



US009455891B2

(12) **United States Patent**  
**Swahar**

(10) **Patent No.:** **US 9,455,891 B2**

(45) **Date of Patent:** **Sep. 27, 2016**

(54) **METHODS, APPARATUS, AND ARTICLES OF MANUFACTURE TO DETERMINE A NETWORK EFFICACY**

(58) **Field of Classification Search**

CPC ..... H04L 67/306; H04L 51/32

USPC ..... 709/224

See application file for complete search history.

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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(21) Appl. No.: **14/471,701**

CA 2677097 8/2008  
EP 1052582 11/2000

(22) Filed: **Aug. 28, 2014**

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(65) **Prior Publication Data**

US 2015/0113129 A1 Apr. 23, 2015

IP Australia, Examination Report, issued in connection with corresponding Australian Patent Application No. 2013203795, on Feb. 5, 2014 (5 pages).

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**Related U.S. Application Data**

(63) Continuation of application No. 12/835,563, filed on Jul. 13, 2010, now Pat. No. 8,874,727.

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(30) **Foreign Application Priority Data**

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May 31, 2010 (IN) ..... 1486/CHE/2010

(57) **ABSTRACT**

(51) **Int. Cl.**

**G06F 15/173** (2006.01)

**H04L 12/26** (2006.01)

**G06F 17/30** (2006.01)

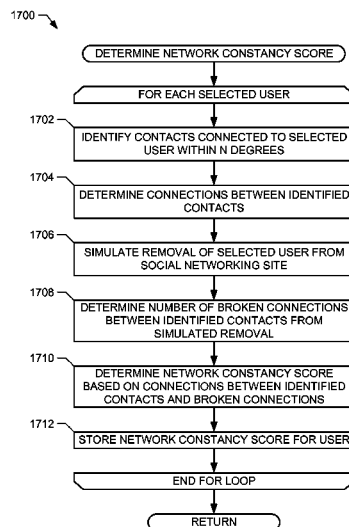
**G06Q 10/10** (2012.01)

Methods, apparatus, and articles of manufacture to determine a network efficacy are described. An example method to determine a network efficacy includes determining a connectedness for a user of a social networking site, determining an interactivity for the user, determining a network constancy for the user, and determining the network efficacy of the social networking site based on the connectedness, the interactivity, and the network constancy.

(52) **U.S. Cl.**

CPC ..... **H04L 43/08** (2013.01); **G06F 17/3053** (2013.01); **G06F 17/30699** (2013.01); **G06F 17/30867** (2013.01); **G06Q 10/10** (2013.01)

**15 Claims, 15 Drawing Sheets**



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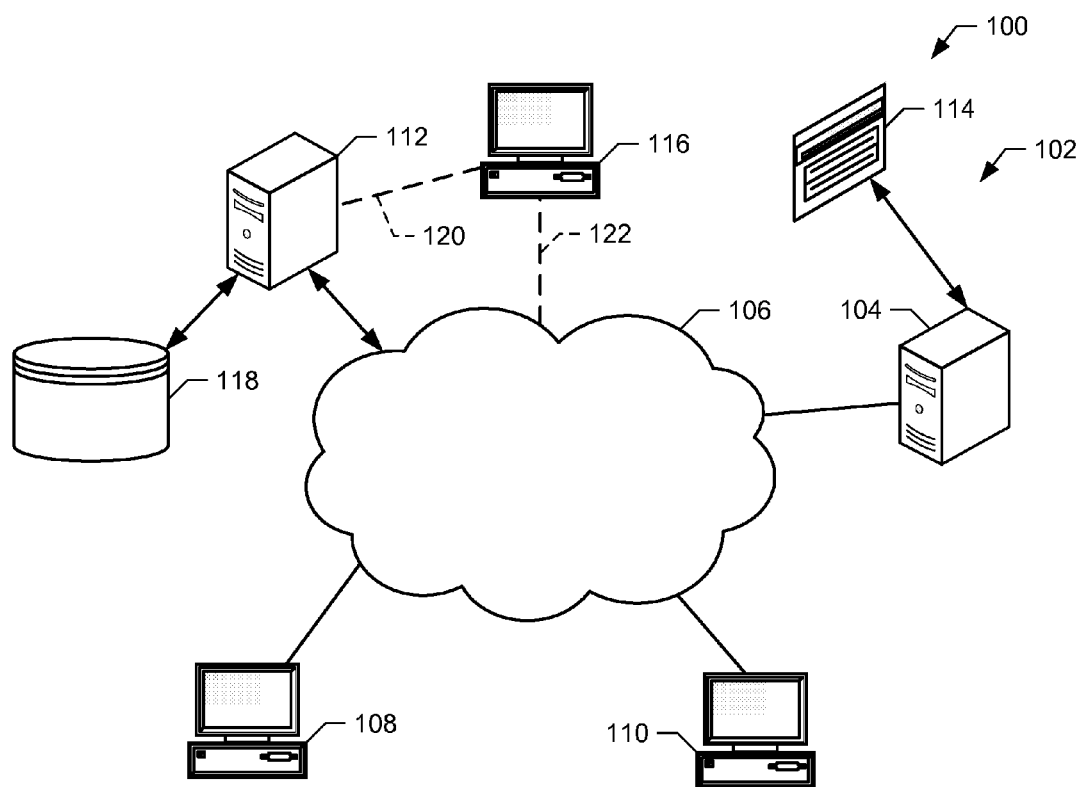
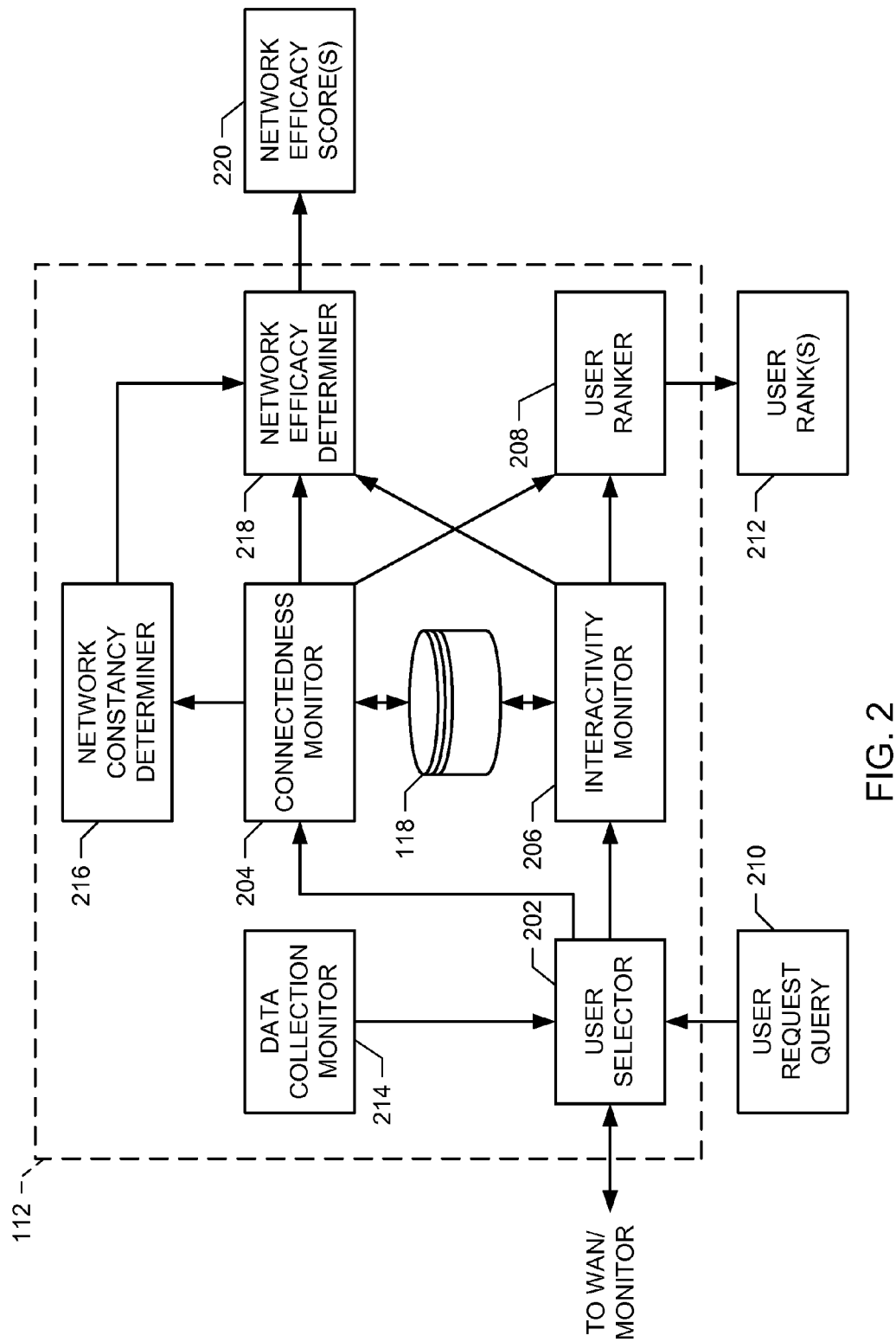


FIG. 1



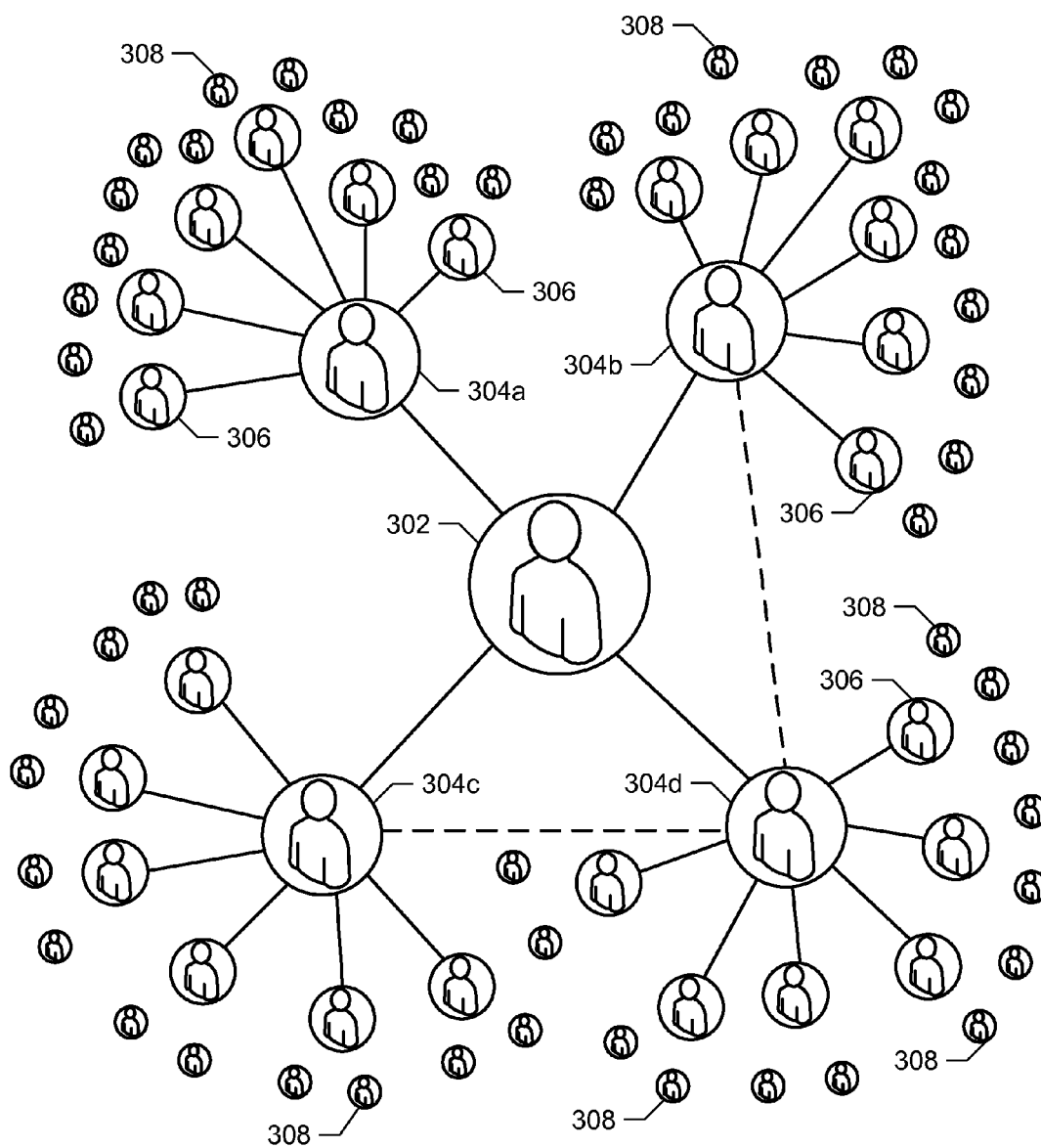


FIG. 3

400

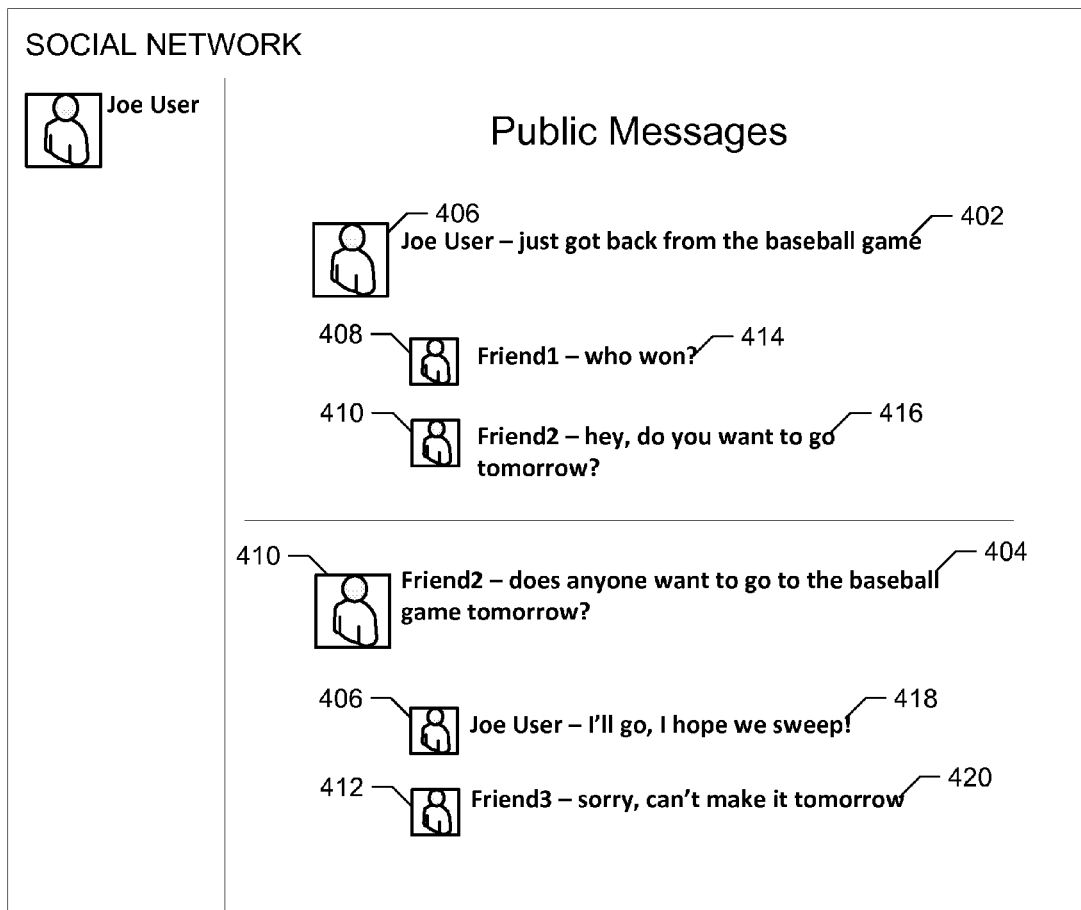


FIG. 4

500

508

502	504	506	INT 1	i	Di1	Di2	Di3	Di4	Di5	Di6	Di7	Di8	Di9	Di10	Di11
			i		1	1	1	1	1	1	1	1	1	1	1
			Di1	1	0	0	0	0	0	0	0	0	0	0	0
			Di2	1	0	0	0	0	0	0	0	0	0	0	0
			Di3	0	0	0	0	0	0	0	0	0	0	0	0
			Di4	0	0	0	0	0	0	0	0	0	0	0	0
			Di5	0	0	0	0	0	0	0	0	0	0	0	0
			Di6	0	0	0	0	0	0	0	0	0	0	0	0
			Di7	0	0	0	0	0	0	0	0	0	0	0	0
			Di8	0	0	0	0	0	0	0	0	0	0	0	0
			Di9	0	0	0	0	0	0	0	0	0	0	0	0
			Di10	0	0	0	0	0	0	0	0	0	0	0	0
			Di11	0	0	0	0	0	0	0	0	0	0	0	0

FIG. 5A

510

512

514

INT 1	i	Di1	Di2	Di3	Di4	Di5	Di6	Di7	Di8	Di9	Di10	Di11
i		1	1	1	1	0	1	1	1	1	1	1
Di1	1	0	0	0	0	0	0	0	0	0	0	0
Di2	1	0	0	0	0	0	0	0	0	0	0	0
Di3	0	0	0	0	0	0	0	0	0	0	0	0
Di4	0	0	0	0	0	0	0	0	0	0	0	0
Di5	0	0	0	0	0	0	0	0	0	0	0	0
Di6	0	0	0	0	0	0	0	0	0	0	0	0
Di7	0	0	0	0	0	0	0	0	0	0	0	0
Di8	0	0	0	0	0	0	0	0	0	0	0	0
Di9	0	0	0	0	0	0	0	0	0	0	0	0
Di10	0	0	0	0	0	0	0	0	0	0	0	0
Di11	0	0	0	0	0	0	0	0	0	0	0	0

FIG. 5B

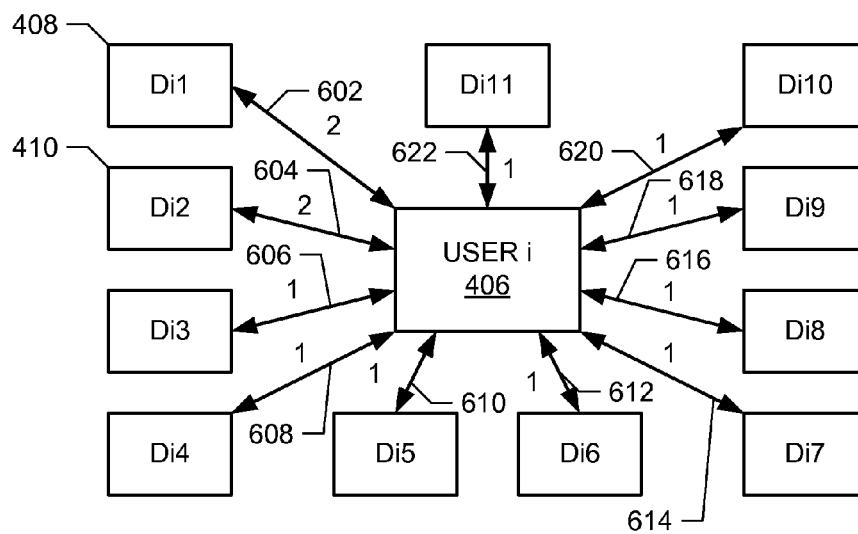


FIG. 6

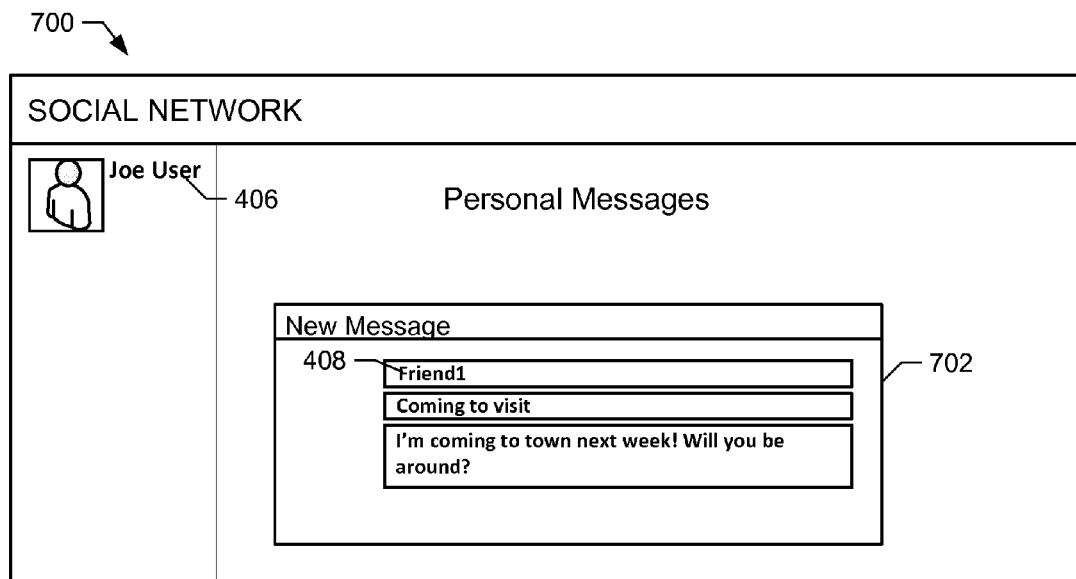


FIG. 7

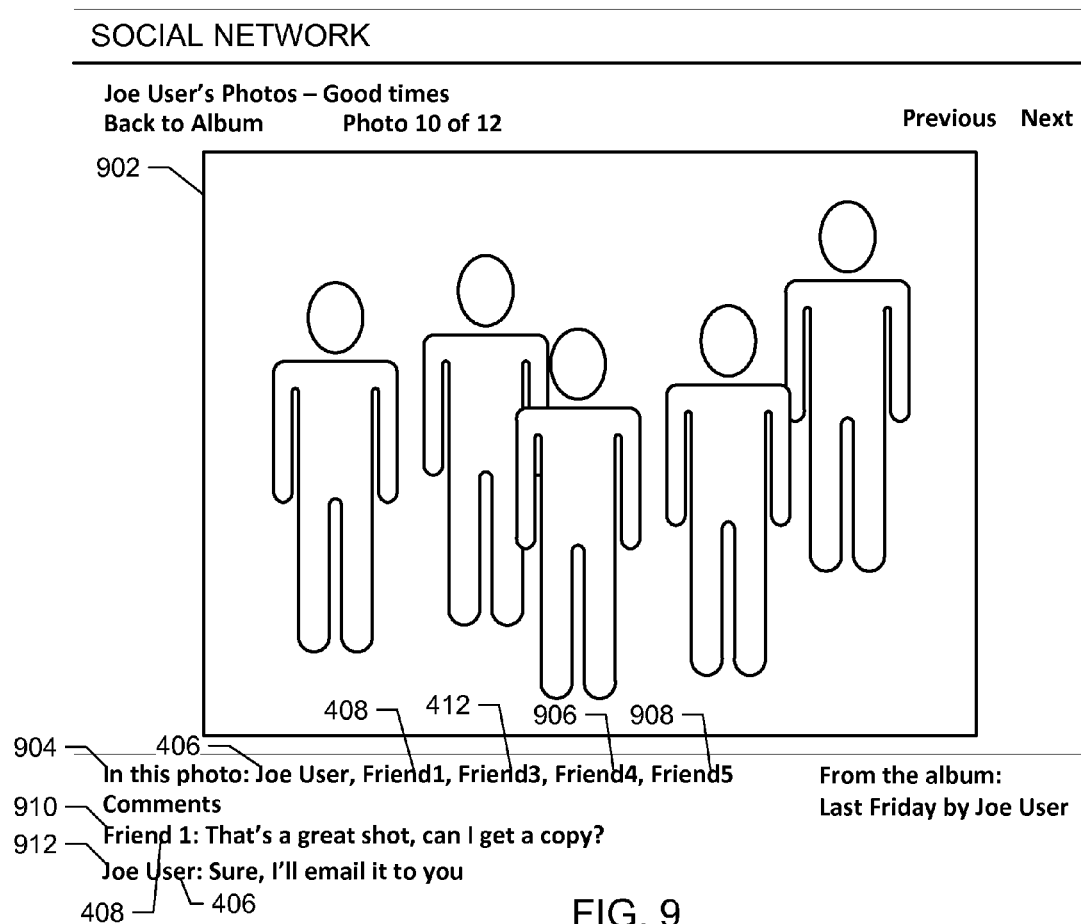
800

802

804

INT 1	i	Di1	Di2	Di3	Di4	Di5	Di6	Di7	Di8	Di9	Di10	Di11
i		1	0	0	0	0	0	0	0	0	0	0
Di1	0	0	0	0	0	0	0	0	0	0	0	0
Di2	0	0	0	0	0	0	0	0	0	0	0	0
Di3	0	0	0	0	0	0	0	0	0	0	0	0
Di4	0	0	0	0	0	0	0	0	0	0	0	0
Di5	0	0	0	0	0	0	0	0	0	0	0	0
Di6	0	0	0	0	0	0	0	0	0	0	0	0
Di7	0	0	0	0	0	0	0	0	0	0	0	0
Di8	0	0	0	0	0	0	0	0	0	0	0	0
Di9	0	0	0	0	0	0	0	0	0	0	0	0
Di10	0	0	0	0	0	0	0	0	0	0	0	0
Di11	0	0	0	0	0	0	0	0	0	0	0	0

FIG. 8



1000

1002

1004

INT 1	i	Di1	Di2	Di3	Di4	Di5	Di6	Di7	Di8	Di9	Di10	Di11
i		2	0	1	1	1	0	0	0	0	0	0
Di1	1	0	0	0	0	0	0	0	0	0	0	0
Di2	0	0	0	0	0	0	0	0	0	0	0	0
Di3	0	0	0	0	0	0	0	0	0	0	0	0
Di4	0	0	0	0	0	0	0	0	0	0	0	0
Di5	0	0	0	0	0	0	0	0	0	0	0	0
Di6	0	0	0	0	0	0	0	0	0	0	0	0
Di7	0	0	0	0	0	0	0	0	0	0	0	0
Di8	0	0	0	0	0	0	0	0	0	0	0	0
Di9	0	0	0	0	0	0	0	0	0	0	0	0
Di10	0	0	0	0	0	0	0	0	0	0	0	0
Di11	0	0	0	0	0	0	0	0	0	0	0	0

**FIG. 10**

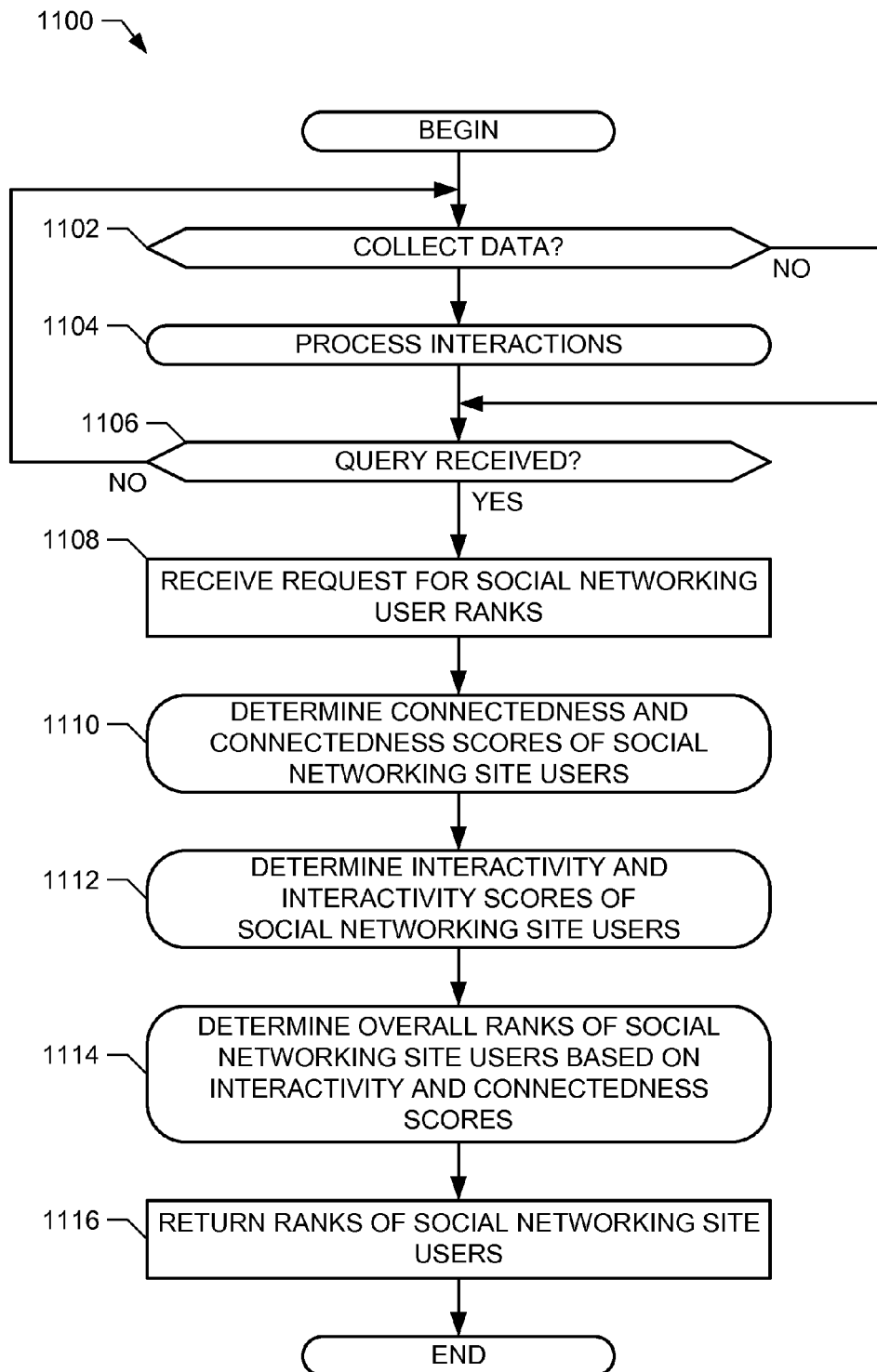


FIG. 11

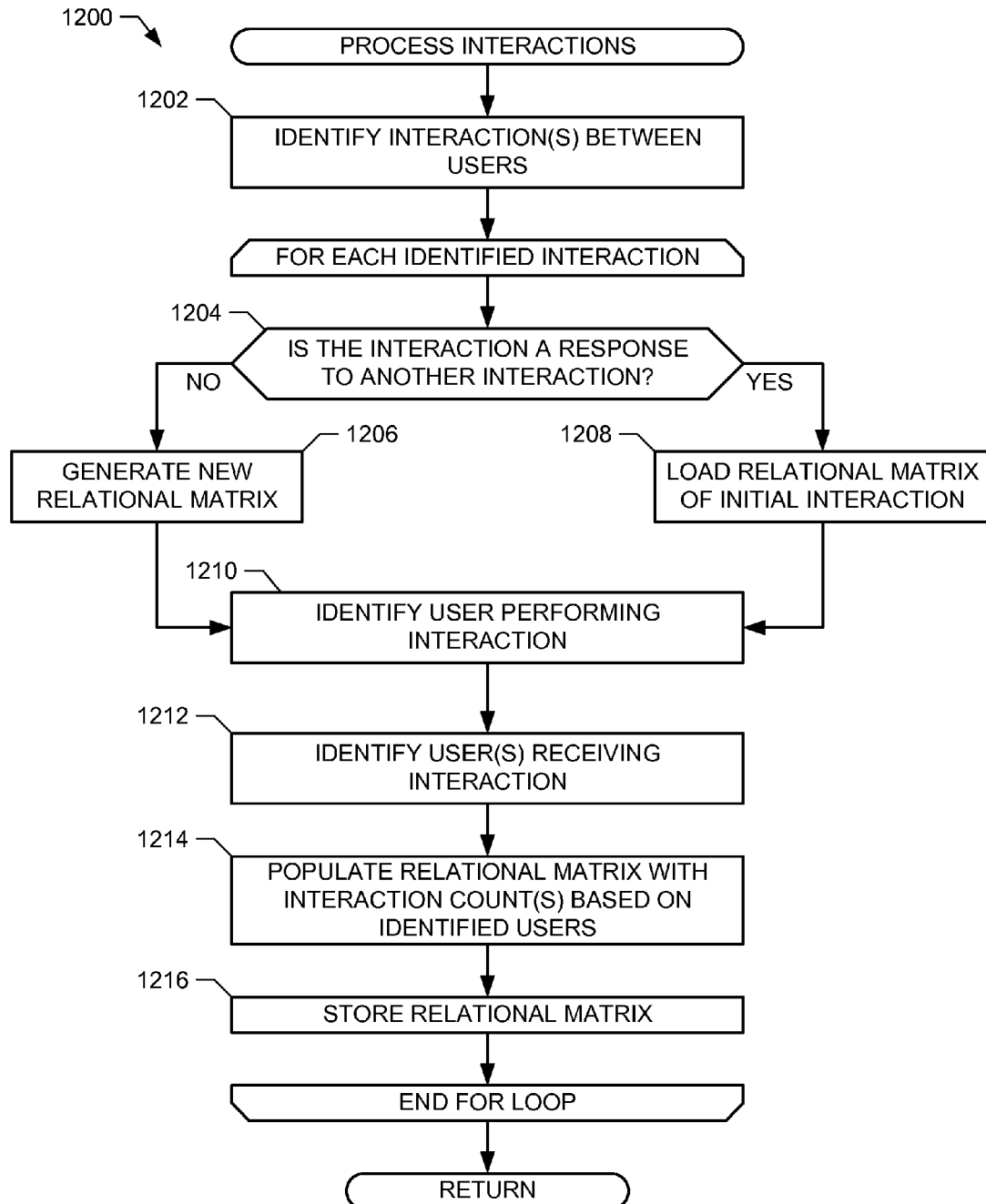


FIG. 12

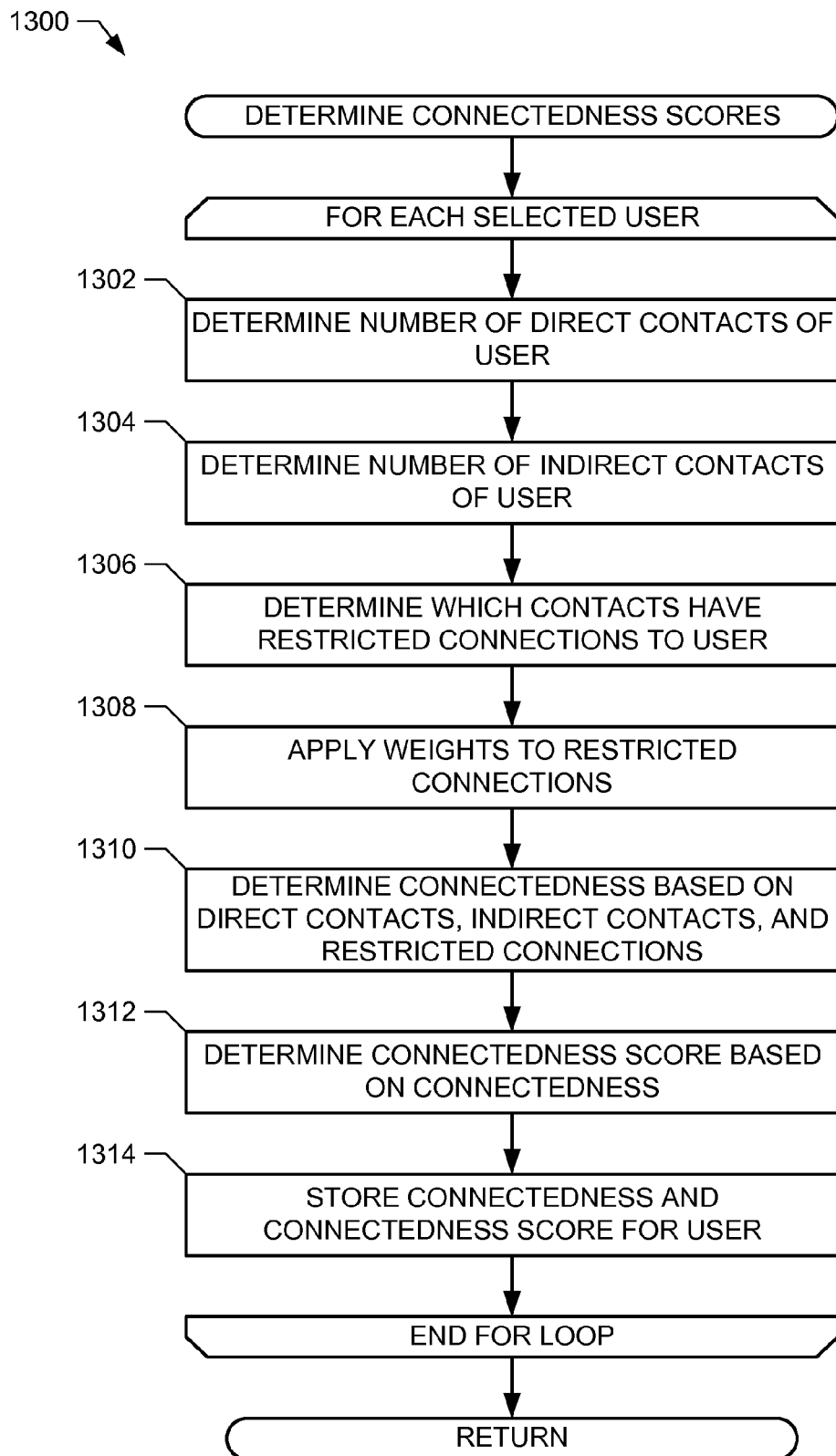


FIG. 13

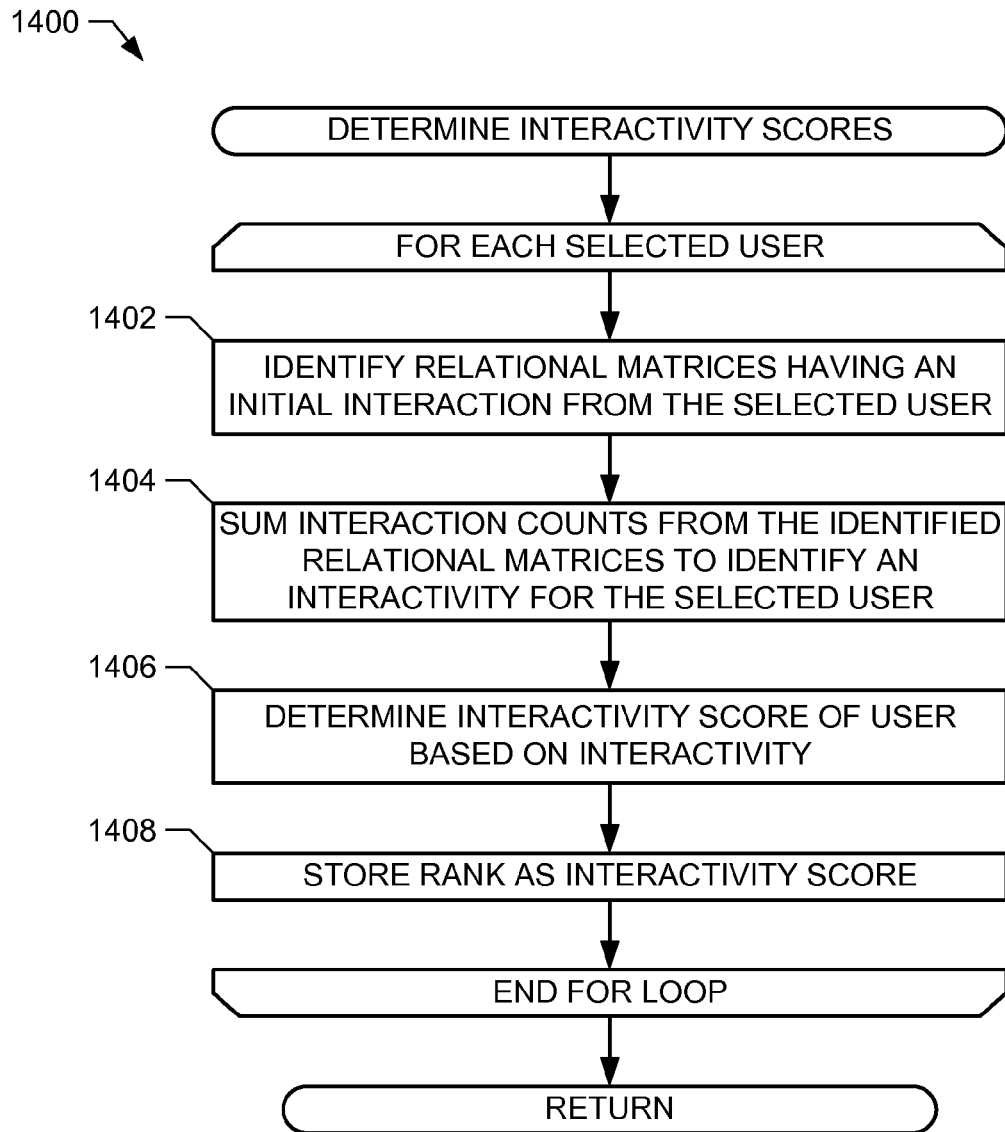
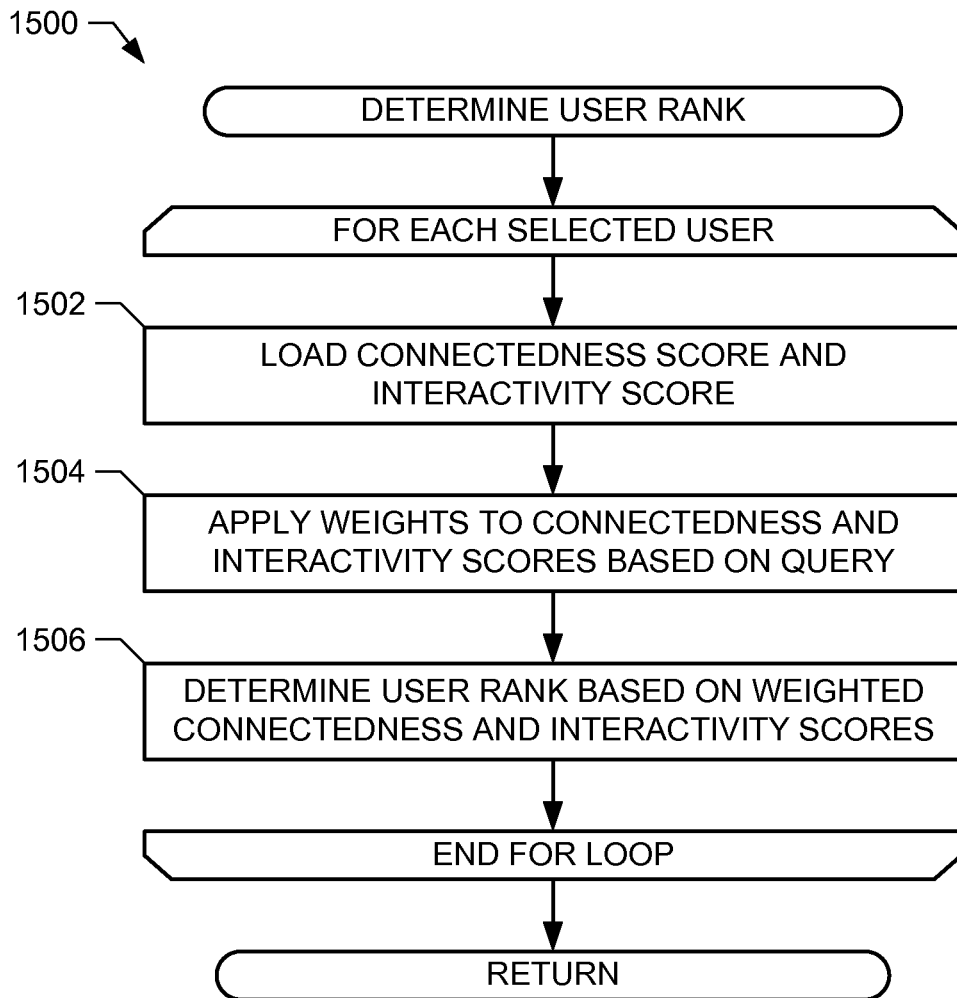


FIG. 14



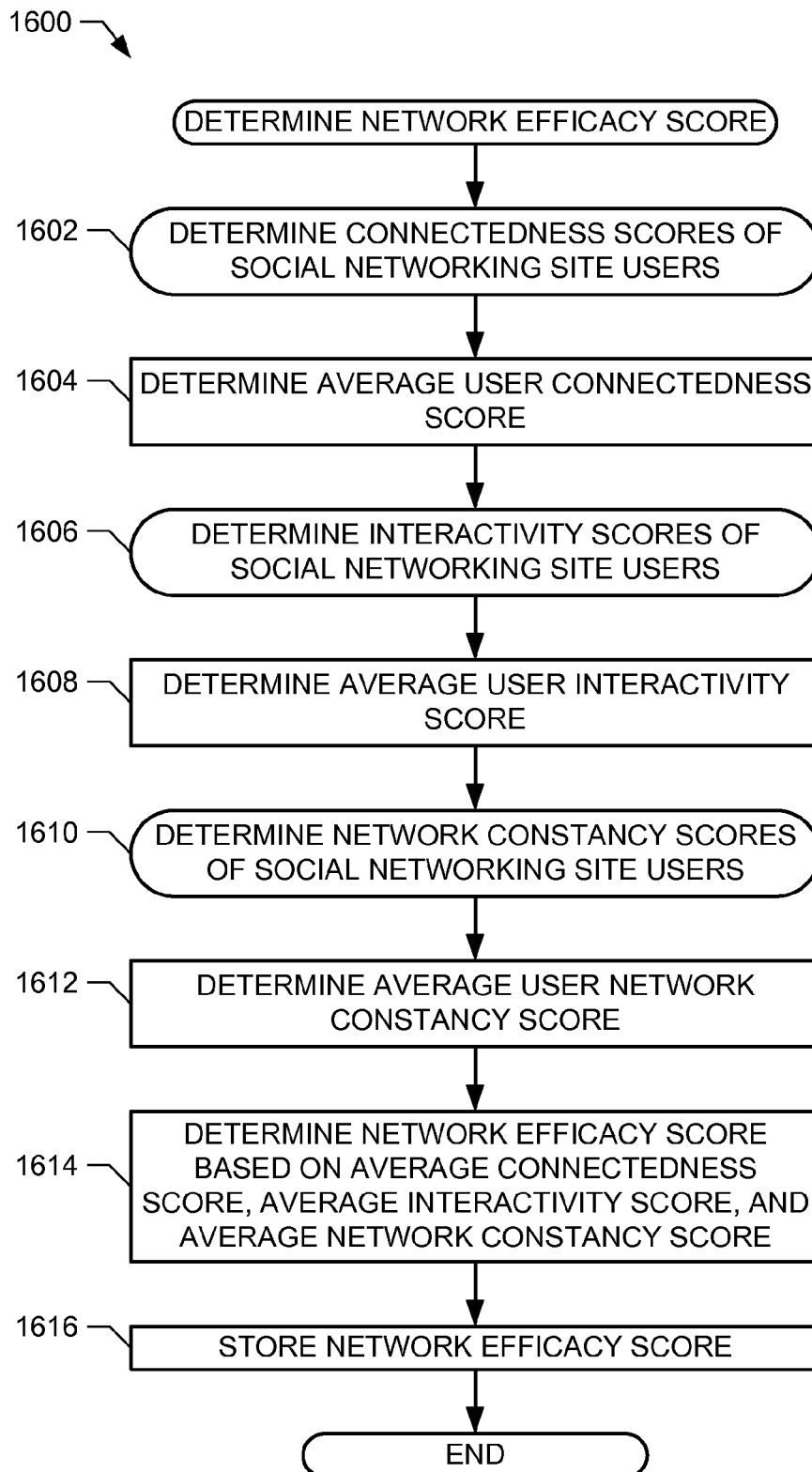


FIG. 16

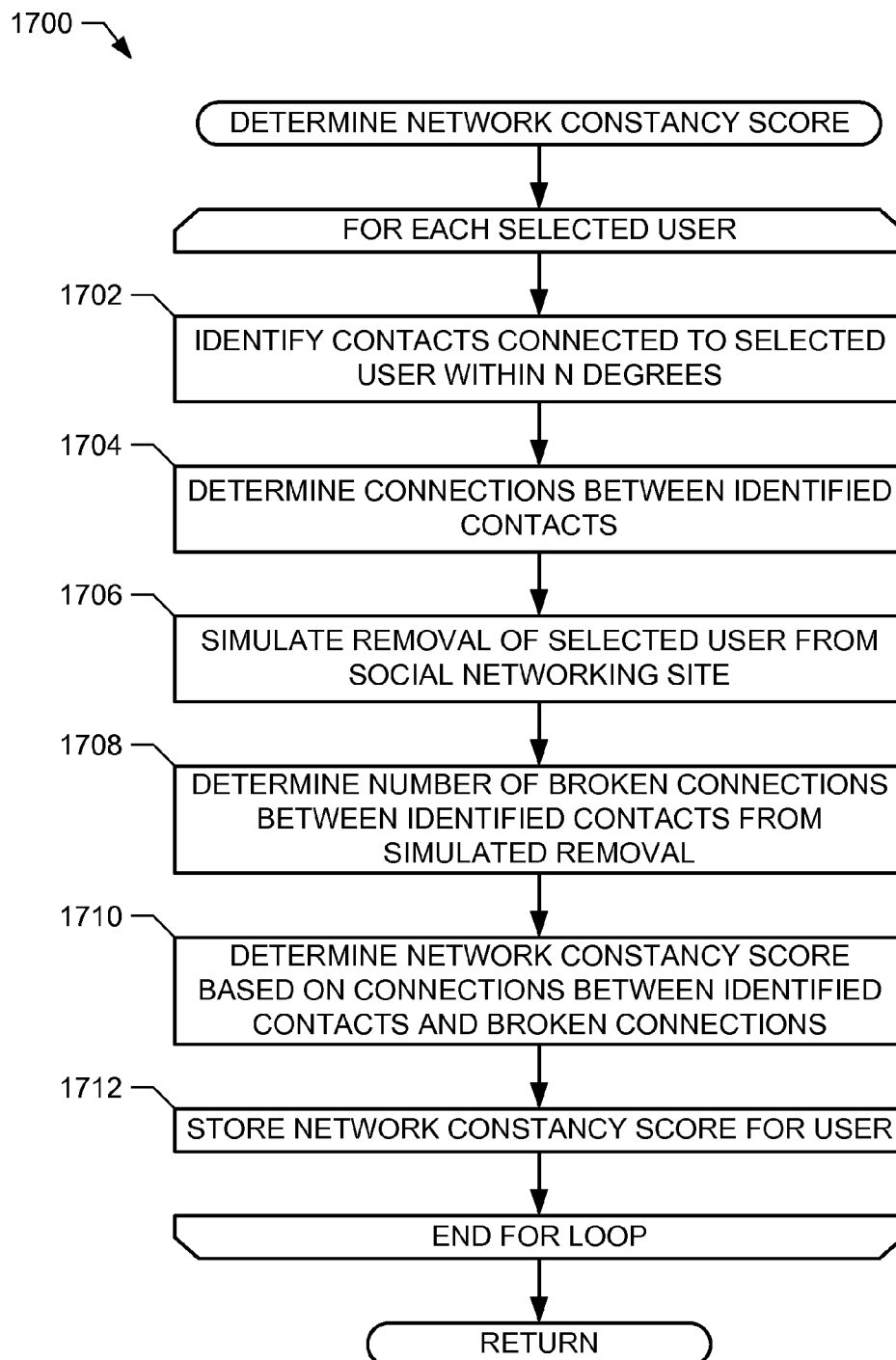


FIG. 17

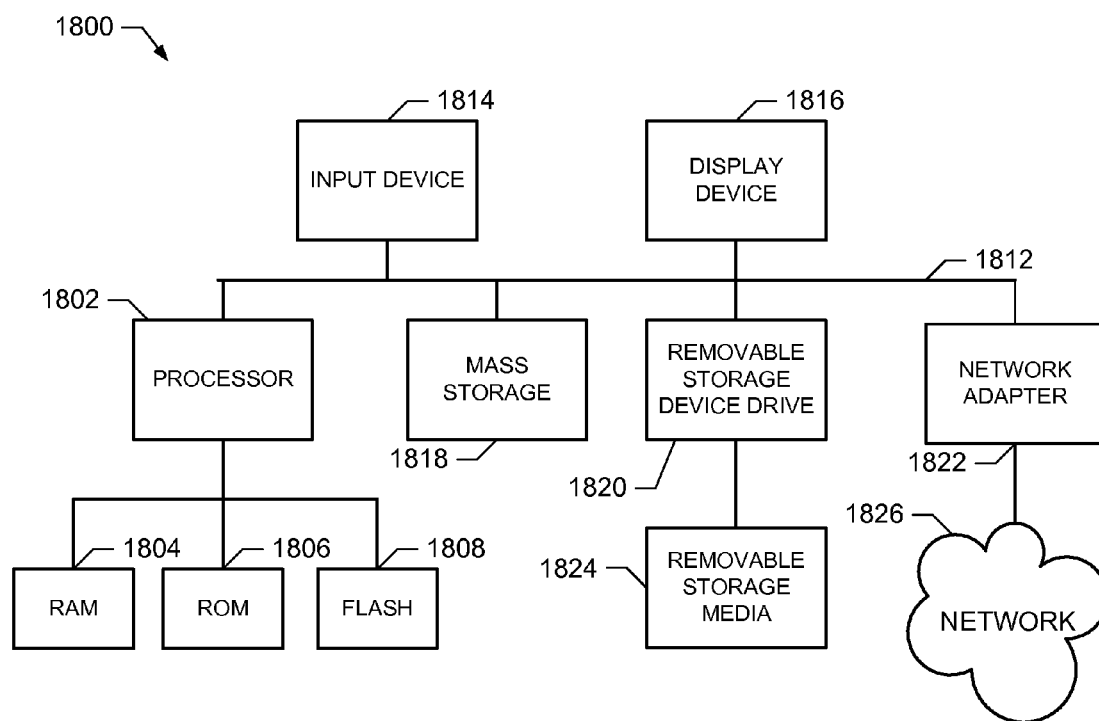


FIG. 18

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## METHODS, APPARATUS, AND ARTICLES OF MANUFACTURE TO DETERMINE A NETWORK EFFICACY

### RELATED APPLICATIONS

This patent arises from a continuation of U.S. patent application Ser. No. 12/835,563, filed Jul. 13, 2010, which claims priority to Indian Patent Application Serial Number 1486/Che/2010, filed on May 31, 2010. The entireties of U.S. patent application Ser. No. 12/835,563 and Indian Patent Application Serial Number 1486/Che/2010 are hereby incorporated by reference.

### FIELD OF THE DISCLOSURE

This disclosure relates generally to measuring social networking and, more particularly, to methods, apparatus, and articles of manufacture to determine a network efficacy.

### BACKGROUND

Social networking has expanded to the online world and enabled more people to stay in contact with larger numbers of personal contacts over great distances. Some social networking web sites allow members to create their own websites, complete with member-provided profile information and ways to contact the member. Social networking web sites keep track of a member's list of contacts, which may be browsed by the member and/or easily recalled via searching the list of contacts. In general, social networking may result in much larger networks of contacts for some users than was previously manageable.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates an example computer network to implement an online social networking website.

FIG. 2 is a more detailed block diagram of the example social networking monitor of FIG. 1.

FIG. 3 illustrates an example social network for a user on an online social networking site.

FIG. 4 illustrates an example social networking webpage including interactions between users and responses to the interactions.

FIG. 5A illustrates an example relational matrix representative of the interactions of FIG. 4.

FIG. 5B illustrates another example relational matrix representative of the interaction of FIG. 4 where a friend of the user has restricted a connection with the user.

FIG. 6 illustrates example vectors representative of the interactions of FIG. 4.

FIG. 7 illustrates an example social networking webpage including a personal message sent from one user to another user.

FIG. 8 illustrates an example relational matrix representative of the interaction of FIG. 7.

FIG. 9 illustrates an example social networking webpage including an image and an interaction between users associated with the image.

FIG. 10 illustrates an example relational matrix representative of the interaction of FIG. 9.

FIG. 11 is a flowchart representative of example machine readable instructions which may be executed to identify popular participants in an online social network.

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FIG. 12 is a flowchart representative of example machine readable instructions which may be executed to process interactions.

FIG. 13 is a flowchart representative of example machine readable instructions which may be executed to determine connectedness scores of users on a social networking site.

FIG. 14 is a flowchart representative of example machine readable instructions which may be executed to determine an interactivity score of a user on a social networking site.

FIG. 15 is a flowchart representative of example machine readable instructions which may be executed to determine a rank of a user on a social networking site.

FIG. 16 is a flowchart representative of example machine readable instructions which may be executed to determine a network efficacy score.

FIG. 17 is a flowchart representative of example machine readable instructions which may be executed to determine a network constancy score of a social networking site.

FIG. 18 is a diagram of an example processor system that may be used to execute the example machine readable instructions of FIGS. 11-17 to implement the social networking monitor of FIG. 2.

### DETAILED DESCRIPTION

Although the example systems described herein include, among other components, software executed on hardware, such description is merely illustrative and should not be considered as limiting. For example, it is contemplated that any or all of the disclosed hardware and/or software components could be embodied exclusively in dedicated hardware, exclusively in software, exclusively in firmware or in some combination of hardware, firmware, and/or software.

The example systems, methods, and articles of manufacture described herein may be used to identify popular or influential participants on an online social networking website (also referred to as a social networking site, or SNS), such as Facebook®, Orkut®, MySpace®, Flickr®, etc. In particular, the example systems, methods, and articles of manufacture described below may be used to facilitate marketing products and services more effectively by identifying users on a social networking site who may result in higher advertisement conversion rates (e.g., sales per advertisement view) and, thus, a better return on marketing investment. The example systems, methods, and articles of manufacture described below may also be used to identify popular participants in other types of online interaction applications such as electronic mail (email), weblogs, and/or other types of user-generated content web sites.

In general, social network analysis refers to mapping and/or measuring the connections and/or relationships between entities (e.g., individuals, groups, organizations). Social network analysis may measure social network activity by determining which individuals are directly connected and then determining how many direct connections one individual is removed from another individual. For example, if individual A is a friend of a friend C of individual B (and is not a direct friend or contact of B), A and B are separated by two degrees (e.g., a first link (degree) between A and an intermediate friend C and a second link (degree) between the intermediate friend C and B). An opinion leader in social networking refers to a person who is highly influential in a local network. Such a person is someone whom others may seek out for advice and/or information. Similarly, on social networking sites where networks may be much more geographically widespread than, for example, local networks, some users of a social networking site may have more

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connections than other users. Thus, some examples systems, methods, and articles of manufacture disclosed herein measure direct and/or indirect connections of a user on a social networking site and generate a connectedness score representative of a user's connectedness. In some examples, the connectedness score is based on a rank of the user with other users.

Some example systems, methods, and articles of manufacture disclosed herein identify the more popular and/or influential users on an online social networking site. In online social networking, some particular users may have a high number of connections. As used herein, the term "user" may refer to an individual, group, organization, business, governmental unit, and/or any other real or fictitious unit or entity that may be represented in social networking. In some examples, a connection identifier determines a number of connections for a specified user. In some examples, the number of connections is a sum of first-degree, second-degree, and/or third-degree connections. The example connection identifier may further determine a number of the connections that are restricted and may decrease the value of restricted connections. A restricted connection refers to a connection (direct or indirect) between individuals where at least one of the individuals has chosen to block some or all types of communications between the individuals. For example, if one of the individuals declines to be updated with the other individual's status, the connection may be considered restricted.

The interactivity of a user refers to the number of interactions between the user and the contacts, connections, and/or friends of the user occurring on a social networking site. An interaction may be any form of activity taking place on a social networking site and/or any response to an activity on a social networking site, including but not limited to: posting to a wall (e.g., a public or semi-public posting board belonging to a user to which anyone with the proper permissions may write or post); sending private messages; chatting; viewing or posting images, videos, and/or other media; commenting on another user's posted status; viewing the friends of a user; notifications of user status updates; and/or posting the results of an application (e.g., event invitations, game scores, etc.). An interactivity score of a user is a normalized and/or ranked score based on the interactivity of a user compared to the interactivities of other users on the social networking site.

Further, in general some users tend to have a higher level of activity and/or interactivity on the social networking site. Due to the highly interactive nature of social networking sites, activity by a user is often in the form of interaction (e.g., messaging a community, to and/or from one or more other entities) with other users. In some examples, an interactivity monitor determines a level of interactivity of a user on the social networking site. Interactivity may refer to any type of interactivity between a user and one or more of the user's direct and/or indirect connections. As used herein, each action in a social transaction is an interaction. Thus, a uni-directional action (e.g., an action from user A to user B) has one interaction, a bidirectional transaction has two interactions (e.g., an action from A to B is a first interaction and a response from B to A is a second interaction), and a multi-directional interaction includes 3 or more interactions. In some examples, the interactivity monitor counts each interaction between users. Thus, for example, an interaction from a user directed at 10 other users counts as 10 interactions. In some examples the interactivity monitor counts responses to an interaction by generating a data structure (e.g., a relational matrix, a vector) for the interaction and

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updating the data structure to count one or more response interactions after they are performed.

In some examples, a user ranker determines an overall rank of a user on a social networking site based on the interactivity of a user and the connectedness of the user. The rank of a user may be indicative of the user's popularity on the social networking site, because popular users may be more likely to be more connected with other users and/or may be more likely to be more active on the social networking site. The connectedness of a user refers to the weighted or unweighted number of users to which the user is directly or indirectly connected, whereas the connectedness score is a normalized or ranked (e.g., percentile ranked) score based on the connectedness of the user compared to the connectedness of other users. In some examples, the interactivity and/or the connectedness of the user are converted into scores. Example scores include a percentile rank of the user for the interactivity of the user and a percentile rank of the user for connectedness. In some examples, the interactivity score and the connectedness score are weighted equally to determine an overall (e.g., composite) user rank. In other examples the interactivity score and the connectedness score are weighted differently and then combined to determine the overall (e.g., composite) rank. For example, a first user with a relatively high interactivity score and a relatively low connectedness score and/or a second user with a relatively low interactivity score and a relatively high connectedness score may both be ranked lower than a third user having a high interactivity score and a high connectedness score.

Some example systems, methods, and articles of manufacture described herein may employ the user rank to select advertisements for presentation to the corresponding user and/or to associate with views of a user's profile by other users. Instead of being used to select advertisements directly, the ranks can be provided by the entity determining the rank in a report to advertisers. The advertisers may then use the rank alone or in combination with other data to select advertisements. In some examples, an advertiser may identify and/or select users based on the user interactivity score, the user connectedness score, and/or the overall user rank. In some examples, the identified user(s) may be propositioned to endorse and/or otherwise associate with the advertiser's product(s) and/or service(s).

In some examples, the connectedness score(s), the interactivity score(s), and/or the ranking may be used as a measure of efficacy of an online social networking site. In some examples, a user's score(s) and/or overall rank may be presented to the user to inform him or her of the same. For example, some users may perceive a challenge to increase their score(s) and/or to improve their ranking(s), thereby potentially increasing the usage of the site by some users. User exposure to advertising may be affected by usage of the site and, therefore, increased usage of the site by users may increase the advertising exposure by those users and generate increased revenue to the site. The network efficacy score may also allow a social networking site to evaluate its advertising pricing structure to reflect a marketing appeal of the social networking site to advertisers.

FIG. 1 illustrates an example computer network **100** to implement an online social networking site **102**. The network **100** includes a host server **104** that may be implemented, for example, using web hosting servers and/or software. The host server **104** is connected via a wide area network **106**, such as the Internet, to other computers **108** and **110** and/or social networking monitor(s) **112**. The computers **108** and **110** may be employed by users of the social networking site **102** (or others) to view a web page **114** via

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web browser application(s) (e.g., Microsoft's Internet Explorer web browser) executed on the computers **108** and **110**. Upon receiving a request from the computer **108** or **110** via the wide area network **106**, the example host server **104** retrieves data corresponding to the request and transmits data representing the requested web page **114** to the requesting computer **108**, **110**. The host server **104** may further receive messages from users of the computers **108** and **110** that include requests for information associated with one or more interactions between users and/or between a user and the social networking site **102**. Example interactions include, but are not limited to, posting content to a wall (e.g., a public or semi-public posting board belonging to a user to which anyone with the proper permissions may write or post); sending private messages; chatting; viewing or posting images, videos, and/or other media; commenting on a user's status; viewing the friends of a user; notifications of user status updates; and/or posting the results of an application (e.g., event invitations, game scores, etc.).

The example social networking monitor **112** of FIG. **1** also accesses the social networking site **102** via the wide area network **106**. Alternatively, the monitor **112** may be directly connected to, or integrated within, the social networking site **102**. In some examples, the social networking site **102** provides one or more application program interfaces (APIs) that allow the social networking monitor **112** to access data contained on the social networking site **102** that is provided by users. The social networking monitor **112** may be accessed by a monitor terminal **116** that is remote from the social networking monitor **112**. For example, a client (e.g., an advertiser) may use the social networking monitor **112** to identify one or more users of the social networking site **102** based on the connectedness and/or the interactivity of the user(s) by accessing the social networking monitor **112** and/or submitting a request via the monitor terminal **116**. The monitor terminal **116** may be directly connected **120** to the social networking monitor **112** and/or indirectly connected **122** to the monitor terminal (e.g., via the wide area network **106**).

In the example of FIG. **1**, the social networking monitor **112** periodically and/or a periodically queries the social networking site **102** to determine an overall rank, an interactivity score and/or a connectedness score of one or more users of the social networking site **102**. For example, the social networking monitor **112** may collect data from the social networking site **102**, analyze the collected data, and update a database **118** that includes an identification, an interactivity, an interactivity score, a connectedness, a connectedness score, and/or a rank (e.g., an overall rank among users of the social networking site **102**) for one or more of the social networking users. The example database **118** of FIG. **1** associates the identification of a user with his or her respective interactivity score, connectedness score, and/or rank(s). The database **118** may additionally or alternatively store the analyzed interactivity data and/or connectedness data for the users. When the social networking monitor **112** identifies a new user on the social networking site **102**, the social networking monitor **112** generates a new entry in the database **118** corresponding to the user and populates the respective fields with the interactivity score(s), connectedness score(s), and/or rank(s).

FIG. **2** is a more detailed block diagram of the example social networking monitor **112** of FIG. **1**. The example social networking monitor **112** of FIG. **2** receives a request for identification of one or more listings of users of the social networking site **102** (FIG. **1**) based on one or more criteria. The monitor **112** ranks the users of the social networking site **102** based on the received criteria, and provides one or more

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lists identifying the ranked users and/or corresponding user information to the requester. To this end, the example social networking monitor **112** of FIG. **2** includes a user selector **202**, a connectedness monitor **204**, an interactivity monitor **206**, and a user ranker **208**. The example social networking monitor **112** is further shown as including the database **118** of FIG. **1**. However, the database **118** may be external to and in communication with the social networking monitor **112**.

The example user selector **202** receives a user request query **210** (e.g., from the monitor terminal **116** of FIG. **1**). The user request query **210** may include a request for one or more of, for example, a connectedness of one or more users, a connectedness score of one or more users, an interactivity of one or more users, an interactivity score of one or more users, an overall rank of one or more users, and/or a list of users and/or traits (e.g., demographic profile, personal social networking site activity, etc.) of users having specified connectedness, connectedness scores, interactivity, interactivity scores, and/or ranks. Additional traits of users may be obtained via, for example, processing profile information provided to the social networking site **102** by users, screen scraping publicly available information from user profiles, and/or using other methods of determining user traits.

The user selector **202** interprets the user request query **210** and, based on the query **210**, determines which of the connectedness monitor **204** and/or the interactivity monitor **206** are to generate data and/or retrieve previously generated data from the database **118**. In general, the connectedness monitor **204** determines a number of users to which each user is directly and/or indirectly connected via the social networking site **102**. The connectedness monitor **204** then determines a connectedness and a connectedness score of a user. A more detailed description of the operation of the connectedness monitor **204** is provided below with reference to FIG. **3**.

FIG. **3** illustrates an example social network **300** for a user **302** on the social networking site **102** of FIG. **1**. The illustrated social network **300** is focused on the particular user **302** and the connections between other users **304**, **306**, **308** and the user **302**. In the example of FIG. **3**, first-degree, or direct, connections are labeled with reference numeral **304**, second-degree connections (e.g., friend-of-a-friend) are labeled with reference numeral **306**, and third-degree connections (e.g., friend-of-a-friend-of-a-friend) are labeled with reference numeral **308**. The user **304d** is also directly connected to both users **304b** and **304c** as represented by the dashed lines in FIG. **3**. Some connections may be made through multiple channels. For example, if the user **302** was not a direct connection with the user **304b**, the user **302** would be a second-degree connection to the user **304b** through the user **304d**. In some examples the connectedness monitor **204** ignores the connections between two users other than the closest or shortest connection.

The example connectedness monitor **204** of FIG. **2** may weight the first-degree connections **304a-304d**, the second-degree connections **306**, and the third-degree connections **308** differently. For example, a second-degree connection **306** may be considered less of a connection than a first-degree connection **304a-304d**.

For an example person *i* (e.g., the user **302**), Equation 1 shows a number of contacts  $M_i$  including both direct and indirect contacts. In Equation 1,  $D_i$  is the number of direct contacts of the user **302**,  $I2_i$  is the number of second-degree contacts of the user **302**,  $I3_i$  is the number of third-degree contacts of the user **302**, and  $IN_i$  is the number of Nth-degree contacts of the user **302**.

$$M_i = D_i + I2_i + I3_i + \dots + IN_i$$

Eq. 1

In some examples, the numbers of indirect contacts I2i-INi exclude any persons that are connected to the user 302 through a closer degree of connection. For example, the I2i indirect contacts (e.g., the users 306) may exclude any of the direct contacts (e.g., the users 304a-304d) of the user 302 because, as described above, some contacts 304a-304d, 306, 308 may be connected to the user 302 through multiple paths. Similarly, the I3i indirect contacts may exclude any of the direct contacts 304a-304d and/or the second-degree contacts 306 of the user 302, and so on up to the INi Nth-degree contacts. However, in some examples the indirect contacts I2i-INi may include all contacts that may be reached through the respective numbers of degrees to, for example, increase the connectedness scores of those users who have more interconnected networks of contacts.

The connectedness monitor 204 determines a connectedness Ci based on the direct and indirect contacts of the user 302. The example connectedness monitor 204 assigns different weights to the direct contacts Di and the indirect contacts I2i-INi based on the number of steps between the level (e.g., second-degree, third-degree, etc.) of connection and the user 302. Equation 2 is an example of a connectedness Ci for the user 302, where N is the number of degrees or steps between the user 302 and the Nth-degree contacts.

$$Ci = Di + (I2i/2) + (I3i/3) + \dots + (INi/N) \quad \text{Eq. 2}$$

The example connectedness score of Equation 2 may assume that all participants of the network (e.g., the direct contacts Di and the indirect contacts I2i-INi) are given full or substantially full access to the user 302 (e.g., the ability to view and/or contact the user 302) and/or to other users 304a-304d, 306, and 308 of the social networking site 102. However, some social networking sites allow the users 302-308 to control the access given to the other users 302-308 on the social networking site 102. In some examples, users 304-308 that have restricted connections with the user 302 are removed from the corresponding contact count Di, I2i, I3i, or INi. However, in some examples the users 304-308 that have restricted connections with the user 302 are not removed but instead are weighted lower than users 304-308 that have full connections with the user 302. For example, Equation 3 illustrates a connectedness Ci<sub>remove</sub> where the users 304-308 who have a restricted connection with the user 302 are removed, and Equation 4 illustrates a connectedness Ci<sub>weight</sub> having some restricted connections DRi, I2Ri, I3Ri, and INRi have a reduced weight relative to respective ones of the unrestricted connection counts DUi, IU2i, IU3i, and IUNi. In some examples, the connectedness monitor 204 establishes an upper limit on the number of degrees N to be counted, where all connections more than N steps are ignored. In some other examples, the connectedness monitor 204 does not limit the upper value of N.

$$Ci_{remove} = \{Di + (I2i/2) + (I3i/3) + \dots + (INi/N)\} - \{DRi + (I2Ri/2) + (I3Ri/3) + \dots + (INRi/N)\} \quad \text{Eq. 3}$$

$$Ci_{weight} = \{DUi + (IU2i/2) + (IU3i/3) + \dots + (IUNi/N)\} + 0.001 * \{DRi + (I2Ri/2) + (I3Ri/3) + \dots + (INRi/N)\} \quad \text{Eq. 4}$$

In some examples, the weight factor (e.g., 0.001 in Equation 4) applied to the restricted connections DRi, I2Ri, I3Ri, and INRi may be based on the activities or interactions in which the user 302 engages and the notifications that the user 302 or the user 304, 306, or 308 has chosen to restrict. Example interactions that may be blocked include, but are

not limited to, posting to a wall (e.g., a public or semi-public posting board belonging to a user to which anyone with the proper permissions may write or post); sending private messages; chatting; viewing or posting images, videos, and/or other media; commenting on a user's status; viewing the friends of a user; notifications of user status updates; and posting the results of an application (e.g., event invitations, game scores, etc.). In some examples, activities in which the user 302 engages longer or more often are weighted higher than activities in which the user 302 engages less often when such activities are restricted between the user 302 and other users 304-308, and connections that are completely restricted may be weighted highest (i.e., to reduce the amount the connection counts toward the connection score the most of any weight). Thus, the example equations 2-4 may be modified to apply multiple weights according to different restriction combinations.

Many of the interactions may be restricted either by the originating (performing, initiating) user 302 or by the receiving user 304, 306, or 308. Thus, DRi may be the sum of those users 304a-304d to whom the user 302 has restricted viewing the user's 302 activities, those users 304-308 whose activities the user 302 has chosen not to view, those users 304-308 who have blocked the user 302 from viewing their activities, those users 304-308 who have chosen to view less of the user's 302 activities, and/or any other blocking or ignoring options.

After determining a connectedness (e.g., Ci<sub>weight</sub> or Ci<sub>remove</sub>), the example connectedness monitor 204 may make the connectedness of the users 302-308 more comparable by generating a connectedness score (e.g., assigning the user 302 a percentile rank). Equation 5 illustrates an example percentile formula that may be used to determine the percentile rank of a user 302 with respect to his or her connectedness for use as a connectedness score. In Equation 5, X is the number of users 302-308 whose connectedness are less than Ci (e.g., Ci<sub>weight</sub> or Ci<sub>remove</sub>), Y is the total number of unique users in the social networking site 102, and P(Ci) is the percentile of the connectedness Ci. The example connectedness Ci and the connectedness score (e.g., percentile P(Ci)) may be updated regularly or irregularly because the connections in a social networking site change frequently.

$$P(Ci) = (X/Y) * 100 \quad \text{Eq. 5}$$

Returning to FIG. 2, after determining the connectedness and/or the connectedness score(s) of one or more users, the connectedness monitor 204 provides the information to the user ranker 208 and/or to the database 118. The connectedness monitor 204 may further determine network constancy score(s) for one or more users. As described above, a network constancy score represents the degree to which removing a user from the social networking site 102 may reduce the connectedness of the remaining users on the social networking site 102.

In general, the interactivity monitor 206 determines an interactivity and/or an interactivity score for one or more users of the social networking site 102. The interactivity monitor 206 may determine the interactivity of a user by determining (e.g., counting) a number of interactions between the user and other users on the social networking site 102. The interactivity monitor 206 may further convert the interactivity into an interactivity score by, for example, comparing the interactivities of the users of the social networking site 102. Example determinations of an interactivity score are described in more detail below. However, such examples are merely illustrative and may be modified

based on any one or more of the format, the configuration, the purpose, the features, the user population, and/or any other traits of a particular social networking site, and/or based on the type of interactions being measured on the social networking site.

FIG. 4 illustrates an example social networking webpage 400 including interactions 402 and 404 between example users 406, 408, 410, and 412 and response interactions 414, 416, 418, and 420 to the interactions 402 and 404. The example interaction 402 represents, for example, a status update by the user 406, in which the user 406 posts a message intended to be viewed by any users who are directly connected (e.g., first-degree contacts) and/or indirectly connected (e.g., second-degree contacts, etc.) to the user 406. Similar interactions may include posting results from an application (e.g., an online game), updating profile information, posting a link to another website, and/or posting media (e.g., music, video, etc.).

On some social networking sites, the connections (e.g., the users 408 and 410) of the user 406 who posts the status update interaction 402 may respond to the interaction with their own respective response interactions 414 and 416. The responses 414 and 416 may be directed to the user 406, the direct connections of the user 406, any users 408 and 410 who have responded to the interaction 402 to which the response 414 is directed, and/or any other users 406-412 who may be updated with the status of the user 406. On some social networking sites, the ability to notify and update users 408-412 with the status (or other posting) of the user 406 is practically unlimited. For example, the user 406 may make his or her profile available to any user 408-412 of the social networking site 102 (FIG. 1) who wants to subscribe to or follow the user 406 and/or even to any member of the public having access to the wide area network 106 of FIG. 1.

FIG. 5A illustrates an example relational matrix 500 representative of the interactions 402, 414, and 416 of FIG. 4. As described above, a relational matrix (or a vector or other data structure) is generated and/or updated for each interaction 402, 404, 414-420 and/or set of interactions (e.g., the set of interactions 402, 414, and 416, and the set of interactions 404, 418, and 420). In the relational matrix 500, the user 406 is represented as  $i$  and has  $D_i x$  direct contacts. The example user  $i$  406 of FIG. 5A has 11 direct contacts and, therefore, the relational matrix 500 includes contacts  $D_{i1}$ - $D_{i11}$ .

The columns in the matrix 500 represent the users 406-412 at whom an interaction 402, 404, or 414-420 is directed, while the rows in the matrix 500 are the users 406-12 who generate or perform responsive interaction(s) 402, 404, or 414-420. A first row 502 of the matrix 500 represents the interactions performed by the user  $i$  406, including the initial interaction 402 performed by the user  $i$  406. The user 406 (e.g., user  $i$ ) posts the interaction 402 (e.g., a status update) for each of his or her contacts  $D_{i1}$ - $D_{i11}$ , causing the example interactivity monitor 206 (FIG. 2) to enter 1 interaction count into each column in the row 502 corresponding to the contacts  $D_{i1}$ - $D_{i11}$ , for a total of 11 interaction counts for the interaction 402. The example contacts  $D_{i1}$  and  $D_{i2}$  each post a response (e.g., interactions 414 and 416) to the status update interaction 402 as illustrated in respective rows 504 and 506. Thus, the interactivity monitor 206 enters 1 interaction count into the  $i$  column 508 in the rows 504 and 506.

Because the response interactions 414 and 416 may occur some time after the interaction 402, the interactivity monitor 206 may store the relational matrix 500 into a database (e.g., the database 118 of FIG. 1) and retrieve the relational matrix

500 at a later time for updating. While in the illustrated example the interactivity monitor 206 only enters interaction counts into the  $i$  column 508, the interactivity monitor 206 may additionally or alternatively enter interaction counts into one or more of the  $D_{i1}$ - $D_{i11}$  columns to represent interactions by  $D_{i1}$  and/or  $D_{i2}$  with other contacts  $D_{i1}$ - $D_{i11}$  of the user  $i$  406. For example, on some social networking sites any user 406-412 who performs a response interaction 414 to the initial interaction 402 is notified of later response interactions 416 from other users 406-412 to the same initial interaction 402. Additionally or alternatively, some social networking sites notify a user 406 when a direct contact (e.g., the user 408) performs an initial and/or response interaction 402, 404, or 414-420 to a mutual direct contact (e.g., the user 410). The example interactivity monitor 206 may therefore update the relational matrix 500 in accordance with the particular notification and/or interaction tools and/or mechanisms of a particular social networking site. In some examples, the interactivity monitor 206 also enters an interaction count into the  $D_{i1}$  column of the  $D_{i2}$  row 506 to indicate that  $D_{i1}$  (e.g., Friend 1 408 of FIG. 4) is also notified because she previously generated the response interaction 414 and is notified about further response interactions (e.g., 416).

FIG. 5B illustrates another example relational matrix 510 representative of the interaction 402 of FIG. 4 where a direct contact  $D_{i5}$  of the user 406 has restricted or blocked status update interactions from the user 406. Some social networking sites provide their respective users 406-412 options to block notifications about one or more of their direct and/or indirect contacts. For example, a user 412 may choose not to be notified when the user 406 performs one or more of: posting to a wall; sending private messages; chatting; viewing or posting images, videos, and/or other media; commenting on a user's status; viewing the friends of a user; notifications of user status updates; posting the results of an application (e.g., event invitations, game scores, etc.); and/or any other interaction(s) with the social networking site 102. The example relational matrix 510 of FIG. 5B is representative of the example interaction 402 and the response interactions 414 and 416 of FIG. 4, except that the direct contact  $D_{i5}$  of the user 406 has chosen to ignore or block one or more types of status updates from the user 406, of which the interaction 402 is one type. The example interactivity monitor 206 of FIG. 2 may determine notification settings of the direct contacts  $D_{i1}$ - $D_{i11}$  of the user 406 and determine, based on the notification settings, that the contact  $D_{i5}$  has disabled notifications for status updates (e.g., restricted, ignored, blocked, etc.). Thus, when the user  $i$  406 generates the interaction 402 directed at the contacts  $D_{i1}$ - $D_{i11}$ , the interactivity monitor 206 determines that there is no interaction between the user  $i$  406 and the contact  $D_{i5}$ , and therefore does not enter an interaction count in a column 512 corresponding to the contact  $D_{i5}$  and a row 514 corresponding to the interaction 402.

FIG. 6 illustrates example vectors 602-622 representative of the interactions 402, 414, and 416 of FIG. 4. The example vectors 602-622 may be used as an alternative to the example relational matrix 500 illustrated in FIG. 5A to store the interaction counts of FIG. 4. In the example of FIG. 6, the interactivity monitor 206 generates a vector 602-622 for each connection between the user  $i$  406 and the participants  $D_{i1}$ - $D_{i11}$  in the interaction 402. Each of the vectors 602-622 has a weight that is representative of the number of interaction counts between the user  $i$  406 and the corresponding user  $D_{i1}$ - $D_{i11}$ . For example, the vector 602 that includes the user  $i$  406 and the user  $D_{i1}$  (e.g., Friend 1 408) has a weight

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of 2 because the interaction 402 and the response interaction 414 include the users 406 and 408. In contrast, the weight of the example vector 606 is 1 because only the interaction 402 includes the user i 406 and the user D<sub>i</sub>3. Additionally or alternatively, the vectors 602 and 604, or the vectors 602-622, may be bidirectional vectors that include the interaction counts in a first direction from the user i 406 to the respective users 408 and 410 and in a second direction from the respective users 408 and 410 to the user i 406.

FIG. 7 illustrates an example social networking webpage 700 including a personal message interaction 702 sent from a user 406 to another user 408. On the example social networking site 102 of FIG. 1, the user 406 may interact with one or more other users 408-412 by transmitting a message directly to the other user(s) 408-412. The receiving user(s) 408-412 may access the message by, for example, navigating to the social networking site 102 via a web browser to view the message. The example message interaction 702 is directed from the user 406 to the user 408 and to no other users.

FIG. 8 illustrates an example relational matrix 800 representative of the message interaction 702 of FIG. 7. While the example relational matrix 800 includes all of the contacts D<sub>i</sub>1-D<sub>i</sub>11 of the user i 406, the interactivity monitor 206 determines that the interaction 702 only took place between the users 406 and 408. In some examples, however, the relational matrix 700 only includes those contacts D<sub>i</sub>1-D<sub>i</sub>11 who are included in the initial transaction. Thus, the interactivity monitor 206 adds an interaction count to the appropriate column 802 and row 804. If the user 408 does not respond to the interaction 702 (e.g., by sending a reply message), the example matrix 800 may be considered complete, and another relational matrix is created for a later interaction.

FIG. 9 illustrates an example social networking webpage 900 including an image 902 and an interaction 904 between users 406-412 associated with the image 902. The example image 902 may be posted by, for example, the user 406, who further "tags" the picture with identifications of other users 408, 412, 906, and 908 who are also present in the image 902. On some social networking sites (e.g., the social networking site 102 of FIG. 1), users 406-412, 906, and 908 may post comments 910 and 912 about the image 902 for others to view when they view the image 902. In the illustrated example, the users 406 and 408 have left respective comments 912 and 910 about the image 902.

FIG. 10 illustrates an example relational matrix 1000 representative of the interaction of FIG. 9. The example relational matrix 1000 includes the user i 406 and the contacts D<sub>i</sub>1-D<sub>i</sub>11 of the user 406. The interactivity monitor 206 (FIG. 2) determines that the user i 406 posted the image 902 and tagged the respective users 408, 412, 906, and 908 who are in the image 902. In response, the interactivity monitor 206 enters interaction counts into a row 1002 corresponding to interactions by the user i 406 directed at other users 408-412, 906, and 908 within columns corresponding to the receiving users of the interaction (e.g., the posting and/or tagging of the image 902).

The example interactivity monitor 206 further detects the comments 910 and 912 and adds additional interactivity counts to a row 1004 corresponding to the user D<sub>i</sub>1 (e.g., Friend1 408) who generated the response interaction 910, and to the row 1002 corresponding to the user i 406 who generated the response interaction 912. In the illustrated example, the interactivity monitor 206 only generates an interaction count for a response interaction 912 in a column 1006 corresponding to the user D<sub>i</sub>1 408 who generated the

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previous response interaction 910. However, the interactivity monitor 206 may generate interaction counts in any row and/or column based on the particular configuration and/or settings of the social networking site (e.g., the social networking site 102). In general, each social networking site may choose to notify users of interactions and/or activities by other users that may potentially be of interest to them in different ways. Thus, the interactivity monitor 206 may generate interaction counts based on the particular notification settings and/or configurations of the social networking site 102 and/or the users 406-412, 906, and 908.

In some examples, the relational matrices 500, 510, 800, and 1000 are used by the interactivity monitor 206 to determine an interactivity of the user i 406. The interactivity for the example user i 406 may be determined by summing the interaction counts in the relational matrices corresponding to the user i 406 over a specified time period or over all time. In these examples, the interactivity monitor 206 generates similar relational matrices for the users D<sub>i</sub>1-D<sub>i</sub>11 to represent the respective interaction counts for use in determining the respective interactivities of the users D<sub>i</sub>1-D<sub>i</sub>11. In some examples, however, the interactivity monitor 206 uses the relational matrices 500, 510, 800, and 1000 to determine the interactivities for any of the users D<sub>i</sub>1-D<sub>i</sub>11. While these examples may result in fewer relational matrices or other data structures to be stored, the interactivity monitor 206 may have to search through a larger number of relational matrices to determine the interactivity of the user i 406.

An interactivity score of the user i 406 may be determined by, for example, comparing the interactivity of the user i 406 to the interactivities of other users on the social networking site. For example, the interactivities may be normalized based on an upper interactivity, a lower interactivity, a median interactivity, and/or another normalization factor. Additionally or alternatively, the interactivity score may be determined based on a percentile rank of the interactivity of the user i 406.

Additionally or alternatively, any of the relational matrices 500, 510, 800, or 1000 may be represented as a vector or in another data structure format. For example, the relational matrix 500 may be represented according to the following vector: <i; D<sub>i</sub>1,1,1; D<sub>i</sub>2,1,1; D<sub>i</sub>3,1,0; D<sub>i</sub>4,1,0; D<sub>i</sub>5,1,0; D<sub>i</sub>6,1,0; D<sub>i</sub>7,1,0; D<sub>i</sub>8,1,0; D<sub>i</sub>9,1,0; D<sub>i</sub>10,1,0; D<sub>i</sub>11,1,0>. Thus, the example vector identifies the user i 406, the users D<sub>i</sub>1-D<sub>i</sub>11, and the interaction counts directed at each of the users D<sub>i</sub>1-D<sub>i</sub>11 by the user i 406 and the interaction counts directed at the user i 406 by each of the users D<sub>i</sub>1-D<sub>i</sub>11. Of course, other vector formats may be used instead of the example vector or the relational matrices 500, 510, 800, or 1000.

Returning to FIG. 2, after the interactivity monitor 206 determines the interactivities and/or the interactivity scores for the users, the interactivity monitor 206 provides the interactivities and/or the interactivity scores to the user ranker 208 and/or to the database 118. In some examples, the interactivity monitor 206 regularly processes interactions (e.g., batch processing) between users of the social networking site 102 and stores the resulting generated and/or updated relational matrices and/or vectors in the database 118. To this end, a data collection monitor 214 determines whether data collection should occur and controls the interactivity monitor 206 accordingly. Additionally or alternatively, the data collection monitor 214 may control the connectedness monitor 204 to collect and/or process the connectedness of the users of the social networking site 102 at regular and/or irregular intervals.

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The user ranker **208** of FIG. 2 receives the connectedness and/or the connectedness scores from the connectedness monitor **204** and/or the interactivities and/or the interactivity scores from the interactivity monitor **206**. Based on the received information, the user ranker **208** determines user rank(s) **212** for one or more users of the social networking site **102** (e.g., based on the user request query **210**). The user rank(s) may then be output to the location from which the user request query **210** was received (e.g., the monitor terminal **116** of FIG. 1) and/or to a different location (e.g., a storage device, a central data facility, an advertiser, database **118**).

The user ranker **208** may generate user rank(s) by, for example, weighting the interactivity score and the connectedness score and then combining the weighted scores to generate an overall (e.g., composite) rank. The weight(s) applied to the connectedness score and/or the interactivity score may be equal or different based on, for example, the user request query **210**. For example, if an advertiser believes that its products are more likely to sell by simply informing users of its products, the user ranker **208** may weight the connectedness score of the users more heavily than the interactivity scores.

The example social networking monitor **112** further includes a network constancy determiner **216** to determine a network constancy score for one or more users in the social networking site **102**. The network constancy score for a user is representative of a number of connections that would be broken, and/or increased in degree by more than a threshold number of degrees, if the user was removed from the social networking site. The network constancy score may be used by, for example, an advertiser or marketer to determine the efficacy of a particular social networking site. For example, if a social networking site has users having low networking constancy scores relative to other social networking sites, the social networking site may be considered less stable because removing users from the social networking site may also remove larger numbers of connections, thereby decreasing the connectedness of the users on the social networking site. Less stable social networking sites are likely less desirable places to purchase advertisements and/or longer running advertising campaigns.

To determine a network constancy score, the connectedness monitor **204** determines the connections between the user (e.g., the user **302** of FIG. 3) and the other users **304-308** to which the user is connected. The network constancy determiner **214** then evaluates the connections between the users **304-308** to determine which of the users **304-308** would, if the user **302** was removed from the social networking site **102**, be disconnected from each other, be connected to each other at a higher degree of separation, and/or continue to be connected to each other.

The network constancy score may be, for example, a proportion of the users **304-308** who would remain connected within a degree threshold when the user **302** is removed from the social networking site **302**. In some examples, the network constancy score may be weighted according to the degree of the connections that are dropped. For example, a second-degree connection that is broken may be weighted higher (and therefore affect the network constancy score more) than a fifth-degree connection that is broken.

In an example, the network constancy determiner **214** may determine a network constancy score for the user **302** of FIG. 3. By removing the user **302** from the network, the user **304a** is disconnected from the users **304b-304d**. However, the users **304b-304d** remain connected. Thus, three

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second-degree connections (e.g., the users **302a** and **302b**, **302a** and **302c**, and **302a** and **302d**) are broken while two first-degree connections (**302b** and **302d**, and **302c** and **302d**) and a second-degree connection (**302b** and **302c**) remain unbroken. Using the ratio of broken connections up to second-degree connections as the example network constancy score, the network constancy score for the user **302** is 0.5. However, the network constancy score may use a higher degree of connection and/or a ratio of different factors (e.g., users connected or disconnected).

The example social networking monitor **112** further includes a network efficacy determiner **218** to determine a network efficacy score **220**. The example network efficacy determiner **218** determines a network efficacy of the social networking site **102** based on an average user connectedness of the users of the social networking site **102**, the average interactivity of the users of the social networking site **102**, and/or the network constancy scores for the users of the social networking site **102**. An example determination of network efficacy *E* is shown in Equation 6 below, where *C* is the average connectedness of the users, *I* is the average interactivity of the users, and *X* is the average network constancy of the users of the social networking site **102** for which the a network efficacy score.

$$E = C + I - X$$

Eq. 6

The network efficacy determiner **218** may generate the network efficacy score(s) **220** for one or more social networking sites **102** (or other types of interaction web sites and/or services such as online messaging) in response to, for example, a request from an advertiser. An advertiser may be interested in comparing, for example, the network efficacies for multiple social networking sites in which the advertiser may be interested in advertising. Additionally or alternatively, the network efficacy determiner **218** may determine network efficacy score(s) **220** at periodic and/or aperiodic intervals to monitor the network efficacy score(s) **220** of social networking sites over time.

FIGS. 11-17 depict example flow diagrams representative of processes that may be implemented using, for example, computer readable instructions that may be used to implement the example user selector **202**, the example connectedness monitor **204**, the example interactivity monitor **206**, the example user ranker **208**, the example data collection monitor **214**, the example network efficacy determiner **218**, and/or, more generally, the example social networking monitor **112** of FIG. 2. The example instructions **1100**, **1200**, **1300**, **1400**, **1500**, **1600**, **1700** of FIGS. 11-17 may be performed using a processor, a controller and/or any other suitable processing device. For example, the example instructions **1100-1700** of FIGS. 11-17 may be implemented using coded instructions (e.g., computer readable instructions) stored on a tangible computer readable medium such as a flash memory, a read-only memory (ROM), and/or a random-access memory (RAM). As used herein, the term tangible computer readable medium is expressly defined to include any type of computer readable storage and to exclude propagating signals. Additionally or alternatively, the example instructions **1100-1700** of FIGS. 11-17 may be implemented using coded instructions (e.g., computer readable instructions) stored on a non-transitory computer readable medium such as a flash memory, a read-only memory (ROM), a random-access memory (RAM), a cache, or any other storage media in which information is stored for any duration (e.g., for extended time periods, permanently, brief instances, for temporarily buffering, and/or for caching of the information). As used herein, the term non-transitory

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computer readable medium is expressly defined to include any type of computer readable medium and to exclude propagating signals.

Alternatively, some or all of the example instructions **1100-1700** of FIGS. **11-17** may be implemented using any combination(s) of application specific integrated circuit(s) (ASIC(s)), programmable logic device(s) (PLD(s)), field programmable logic device(s) (FPLD(s)), discrete logic, hardware, firmware, etc. Also, some or all of the example instructions **1100-1700** of FIGS. **11-17** may be implemented manually or as any combination(s) of any of the foregoing techniques, for example, any combination of firmware, software, discrete logic and/or hardware. Further, although the example instructions **1100-1700** of FIGS. **11-17** are described with reference to the flow diagrams of FIGS. **11-17**, other methods of implementing the instructions **1100-1700** of FIGS. **11-17** may be employed. For example, the order of execution of the blocks may be changed, and/or some of the blocks described may be changed, eliminated, sub-divided, or combined. Additionally, any or all of the example instructions **1100-1700** of FIGS. **11-17** may be performed sequentially and/or in parallel by, for example, separate processing threads, processors, devices, discrete logic, circuits, etc.

FIG. **11** is a flowchart representative of example machine readable instructions **1100** which may be executed to identify popular participants in an online social network (e.g., the social networking site **102** of FIG. **1**). The example machine readable instructions **1100** may be executed by the social network monitor **112** of FIG. **2**.

The example instructions **1100** begin by determining (e.g., via the data collection monitor **214** of FIG. **2**) whether to collect data (e.g., process interactions) (block **1102**). For example, the data collection monitor **214** may determine whether a data collection period has lapsed. If the data collection monitor **214** determines that it is time to collect data (block **1102**), the example interactivity monitor **206** of FIG. **2** processes interactions on the social networking site **102** (block **1104**). Example instructions **1200** to implement block **1104** are described below with reference to FIG. **12**. As described above, the data collection monitor **214** may additionally or alternatively cause the connectedness monitor **204** to process the connectedness of one or more users of the social networking site **102**. After processing the interactions (block **1104**), or if it is not time to collect data (block **1102**), the user selector **202** of FIG. **2** determines whether a query has been received (block **1106**). If a query has not been received, control returns to block **1102** to determine whether it is time to collect data.

If a query is received (block **1106**), the user selector **202** receives the request, such as a user request query **210** (FIG. **2**) for the popularities of one or more users of the social network site **102** (block **1108**). The connectedness monitor **204** of FIG. **2** determines one or more connectedness scores for the users based on the user request query **210** (block **1110**). Block **1110** may be implemented using example machine readable instructions **1300** described below with reference to FIG. **13**. In some examples, the determination of the connectedness scores includes determining the connectedness of the users. The interactivity monitor **206** determines one or more interactivity scores for the users based on the user request query **210** (block **1112**). Block **1112** may be implemented using example machine readable instructions **1400** described below with reference to FIG. **14**. In some examples, the determination of the interactivity scores includes determining the interactivity of the users.

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Based on the connectedness scores and the interactivity scores, the example user ranker **208** of FIG. **2** determines an overall rank for the users (block **1114**). Block **1114** may be implemented using example machine readable instructions **1500** described below with reference to FIG. **15**. The user ranker **208** then returns the popularities of the users of the social networking site **102** (e.g., to the monitor terminal **116** of FIG. **1**, to a computer **108** of a user of the social networking site **102** of FIG. **1**, and/or to another requester location) (block **1118**). After returning the popularities of the users, the example instructions **1100** may end or iterate to continue processing interactions and/or responding to requests.

FIG. **12** is a flowchart representative of example machine readable instructions **1200** which may be executed to process interactions. The example instructions **1200** may be executed to implement the example interactivity monitor **206** of FIG. **2** to execute block **1104** of FIG. **11**. The instructions **1200** may begin when the data collection monitor **214** determines that it is time to process interactions between users on the social networking site **102**.

To process interactions, the example interactivity monitor **206** identifies interactions between users on the social networking site **102** (block **1202**). In some examples, the interactivity monitor **206** discards or ignores those interactions that are identified but were previously processed. For example, the interactivity monitor **206** may ignore at least a portion of a relational matrix that is updated with a new or additional interaction after a previous interaction processing sequence. The example blocks **1204-1216** iterate in a for-loop as described below. In particular, the blocks **1204-1216** may be iterated for each interaction identified by the interactivity monitor **206** in block **1202**.

For a selected interaction, the interactivity monitor **206** determines whether the action is a response interaction corresponding to a previous initial interaction (block **1204**). For example, the interactivity monitor **206** may determine that a status update A by a user is an initial interaction (e.g., is not a response interaction), but may determine that a comment B to the status update A is a response interaction to the earlier status update interaction A. If the selected interaction is not a response interaction (e.g., the interaction is an initial interaction) (block **1204**), the example interactivity monitor **206** generates a new relational matrix corresponding to the selected interaction (block **1206**). In contrast, if the selected interaction is a response interaction (block **1204**), the interactivity monitor loads a previously-created relational matrix corresponding to the initial interaction to which the selected interaction is a response (block **1208**).

After generating a new relational matrix (block **1206**) or loading a relational matrix (block **1208**), the example interactivity monitor **206** identifies a user (e.g., the user **i 406** of FIG. **4**) that performed the interaction (block **1210**). For example, the user that performs a status update is the poster of the update and the person that performs a comment to a status update is the commenter. Thus, the interactivity monitor **206** identifies the poster of a status update or to a user commenting on a status update. The interactivity monitor **206** also identifies user(s) (e.g., the user(s) **408-412** of FIG. **4**) receiving the interaction (block **1212**). For example, a user receiving the interaction may be a user **408** who is a direct contact of the user **i 406** and receives a notification that the user **i 406** has updated his or her status.

Based on the identified performing and receiving users, the interactivity monitor **206** populates the relational matrix with interaction count(s) (block **1214**). The example inter-

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activity monitor **206** then stores the relational matrix (block **1216**). After storing the relational matrix (block **1216**), the for-loop may iterate to select another identified interaction or may return control to the example instructions **1100** of FIG. **11**. While the example instructions **1200** have been described with reference to a relational matrix, the example instructions may additionally or alternatively be used with a vector or other data structure.

FIG. **13** is a flowchart representative of example machine readable instructions **1300** which may be executed to determine connectedness scores of users on a social networking site (e.g., the social networking site **102** of FIG. **1**). The example instructions **1300** may be used to implement the example connectedness monitor **204** of FIG. **2** to execute block **1110** of FIG. **11**.

The example instructions **1300** may enter from block **1108** of FIG. **11**. The example connectedness monitor **204** iterates blocks **1302-1312** for each user on the example social networking site **102**. For a selected user (e.g., the user **302** of FIG. **3**), the connectedness monitor **204** determines a number of direct contacts (e.g., the users **304a-304d**) of the user **302** (block **1302**). The connectedness monitor **204** further determines a number of indirect contacts (e.g., the users **306-308**) of the user **302** (block **1304**). Additionally, the connectedness monitor **204** determines which contacts **304-308** have restricted connections to the user **302** (block **1306**).

The example connectedness monitor **204** then applies weights to the restricted connections (block **1308**). The connectedness monitor **204** may apply weights to different numbers of direct **304a-304d** and indirect contacts **306-308** based on the restrictions between respective ones of the users **304-308** and the user **302**. For example, the connectedness monitor **204** may apply a higher (e.g., larger) weight (or a unit weight) to the user **304b** who has an unrestricted connection to the user **302**, and may apply a lower (e.g., smaller) weight to the user **304c** who has a restricted connection to the user **302**. The connectedness monitor **204** determines a connectedness for the selected user **302** based on the unrestricted direct contacts **304a-304b**, the unrestricted indirect contacts **306-308**, and the restricted direct and/or indirect contacts (block **1310**). For example, the connectedness monitor **204** may determine the connectedness  $C_{i_{weight}}$  of the selected user using Equation 4 above.

The example connectedness monitor **204** determines a connectedness score of the selected user **302** based on the connectedness (block **1312**). For example, the connectedness monitor **204** may determine the connectedness score based on the connectedness of the selected user **302** compared to the connectedness of other users **304-308** of the social networking site **102**. The connectedness monitor **204** may then store the connectedness and the connectedness score for the selected user **302** (e.g., in the database **118** of FIG. **2**) (block **1314**). After storing the connectedness and the connectedness score, the example instructions **1300** may iterate blocks **1302-1314** for additional users or may return control to block **1112** of FIG. **11**.

FIG. **14** is a flowchart representative of example machine readable instructions **1400** which may be executed to determine an interactivity score of a user on a social networking site (e.g., the social networking site **102** of FIG. **1**). The example instructions may be used to implement the example interactivity monitor **206** of FIG. **2** to execute block **1112** of FIG. **11**. Blocks **1402-1408** of FIG. **14** may iterate for each user of a number of users for which an interactivity score is to be generated.

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The example interactivity monitor **206** may begin after block **1110** of the example instructions **1100** by identifying relational matrices having an initial interaction performed by the selected user (e.g., the user **i 406** of FIG. **4**) (block **1402**). For example, the interactivity monitor **206** may identify those relational matrices previously generated, updated, and/or stored in the database **118** of FIG. **2** by the interactivity monitor **206** during the processing of interactions on the social networking site **102** of FIG. **1**. The interactivity monitor **206** sums the interaction counts from the identified relational matrices to identify an interactivity for the selected user **i 406** (block **1404**). In some examples, the relational matrices are based on an initial interaction performed by the user **i 406**, and therefore the user **i 406** either performs or receives the initial interaction(s) and/or any response interaction(s) included in the relational matrices, and the interaction counts may be attributed to the user **i 406**. In some other examples, however, the relational matrices may include interaction counts that are not associated with the user **i 406**. In this case the interactivity monitor **206** determines the interaction counts for the user **i 406** by, for example, counting interaction counts in the rows and/or columns corresponding to the user **i 406**.

The example interactivity monitor **206** then determines the interactivity score based on the interactivity (block **1406**). For example, the interactivity monitor **206** may determine the interactivity score as a percentile rank of interaction counts for the user **i 406** compared to the number of interaction counts for other users (e.g., the users **408-412**) and/or as a number of interaction counts. The interactivity monitor **206** stores the interactivity and the interactivity score for the selected user **i 406** (block **1408**). The example blocks **1402-1408** may then iterate to determine an interactivity score for another user or may return control to block **1114** of FIG. **11**.

FIG. **15** is a flowchart representative of example machine readable instructions **1500** which may be executed to determine an overall (e.g., composite) rank of a user on a social networking site (e.g., the example social networking site **102** of FIG. **1**). The example instructions **1500** may be used to implement the example user ranker **208** to execute block **1114** of FIG. **11**. The example blocks **1502-1506** may be iterated for each user of a number of users to be ranked.

The example user ranker **208** loads a connectedness score and an interactivity score (block **1502**). For example, the user ranker **208** receives the connectedness score from the connectedness monitor **204** (e.g., generated by executing blocks **1302-1310** of FIG. **13**) and receives the interactivity score from the interactivity monitor **206** (e.g., generated by executing blocks **1402-1406** of FIG. **14**). The user ranker **208** then applies weights to connectedness and interactivity scores based on the query (block **1504**). For example, the user ranker **208** may apply equal weights to the connectedness and interactivity scores or may apply a higher weight to one of the connectedness score or the interactivity score and a lower weight to the other of the scores. For example, the connectedness score may have a higher weight than the interactivity score if the user request query **210** indicates that the connectedness score is more important to the requester than the interactivity score.

The example user ranker **208** then determines the user rank based on the connectedness and interactivity scores (block **1506**). After determining the user rank, the user ranker **208** may iterate blocks **1502-1506** for additional users or may return control to block **1116** of FIG. **11**.

FIG. **16** is a flowchart representative of example machine readable instructions **1600** which may be executed to deter-

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mine a network efficacy score (e.g., for the social networking site **102** of FIG. **1**). The example instructions **1600** may be executed by one or more of the example user selector **202**, the example connectedness monitor **204**, the example interactivity monitor **206**, and/or the example network efficacy determiner **218** to generate the network efficacy score(s) **220** (FIG. **2**) for the social networking site **102**.

The example connectedness monitor **204** may begin by determining connectedness scores for users of the social networking site **102** (block **1602**). Block **1602** may be implemented by the example connectedness monitor **204** of FIG. **2** by executing the example machine readable instructions **1300** of FIG. **13**. The example connectedness monitor **204** and/or the network efficacy determiner **218** may determine an average user connectedness score for the users of the social networking site **102** (block **1604**).

The example interactivity monitor **206** then determines interactivity scores for the users of the social networking site **102** (block **1606**). Block **1606** may be implemented by the interactivity monitor **206** by executing the example machine readable instructions **1400** of FIG. **14**. The example interactivity monitor **206** and/or the network efficacy determiner **218** may determine an average user interactivity score for the users of the social networking site **102** (block **1608**).

The example connectedness monitor **204** further determines network constancy scores for the users of the social networking site **102** (block **1610**). Block **1610** may be implemented by the example connectedness monitor **204** of FIG. **2** by executing the example machine readable instructions **1700** described with reference to FIG. **17** below. The example connectedness monitor **204** and/or the network efficacy determiner **218** may determine an average user network constancy score for the users of the social networking site **102** (block **1612**). While the example blocks **1604**, **1608**, and **1612** determine the average connectedness, the average interactivity, and the average network constancy scores for the users, respectively, the example blocks **1604**, **1608**, and **1612** may additionally or alternatively determine a median score, a mode score, and/or any other score that is representative of the user scores on the social networking site **102**.

The example network efficacy determiner **218** then determines a network efficacy score **220** based on the average connectedness score, the average interactivity score, and/or the average network constancy score (block **1614**). For example, the network efficacy determiner **218** may subtract the network constancy score (where a higher network constancy score represents a higher network instability) from the sum of the interactivity score and the connectedness score. However, other formulations of the network efficacy determiner **218** may be used to determine a network efficacy score. After determining the network efficacy score **220**, the example network efficacy determiner **218** stores the network efficacy score **220** for later retrieval and/or transmittal. In some examples, the network efficacy determiner **218** may transmit the network efficacy score **220** to a requester of the network efficacy score. The example instructions **1600** may then end.

FIG. **17** is a flowchart representative of example machine readable instructions **1700** which may be executed to determine a network constancy score (e.g., the network constancy score **220** of FIG. **2**) of a social networking site (e.g., the social networking site **102** of FIG. **1**). The example instructions **1700** may be executed by the connectedness monitor **204** of FIG. **2** to implement block **1610** of FIG. **16**. Blocks **1702-1712** of the example instructions **1700** may be iterated for multiple users of the social networking site **102**.

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The example connectedness monitor **204** may begin an iteration of a loop by selecting a user of the example social networking site **102** (e.g., the user **302** of FIG. **3**). For the selected user **302**, the connectedness monitor **204** identifies the contacts (e.g., the users **304-308**) who are connected to the selected user **302** within a number N of degrees of connection (e.g., up to a third-degree connection) (block **1702**). The connectedness monitor **204** then determines the connections between the identified contacts (block **1704**). For example, the connectedness monitor **204** may determine that there is a second-degree connection between the user **304a** and each of the users **304b-304d**, etc.

The connectedness monitor **204** simulates a removal of the user **302** from the social networking site **102** (block **1706**). For example, the connectedness monitor **204** may view the user **304a** as disconnected from the users **304b-304d**. Based on the simulated removal, the connectedness monitor **204** determines a number of broken connections that result (block **1708**). The network constancy score for the user **302** may be determined based on the connections between the identified users **304-308** and the broken connections resulting from the removal of the user **302** (block **1710**). For example, the connectedness monitor **204** may determine the network constancy score as the ratio of broken connections to the number of connections between the identified users (e.g., when the user **302** is still considered as in the social networking site **102**). However, other formulations of the network constancy score may be determined.

The example connectedness monitor **204** then stores the network constancy score for the user **302** (e.g., in the database **118** of FIG. **2**) (block **1712**). After storing the network constancy score, the connectedness monitor **204** may iterate by selecting another user of the social networking site **102** and looping control to block **1702** or the example instructions **1700** may end and return control to block **1612** of FIG. **16**.

FIG. **18** is a diagram of an example processor system **1800** that may be used to execute the example machine readable instructions **1100**, **1200**, **1300**, **1400**, **1500**, **1600**, and **1700** described in FIGS. **11-17**, as well as to implement the social network monitor **112** described in FIG. **2**. The example processor system **1800** includes a processor **1802** having associated memories, such as a random access memory (RAM) **1804**, a read only memory (ROM) **1806** and a flash memory **1808**. The processor **1802** is coupled to an interface, such as a bus **1812** to which other components may be interfaced. In the illustrated example, the components interfaced to the bus **1812** include an input device **1814**, a display device **1816**, a mass storage device **1818**, a removable storage device drive **1820**, and a network adapter **1822**. The removable storage device drive **1820** may include associated removable storage media **1824** such as magnetic or optical media. The network adapter **1822** may connect the processor system **1800** to an external network **1826**.

The example processor system **1800** may be, for example, a conventional desktop personal computer, a notebook computer, a workstation or any other computing device. The processor **1802** may be any type of processing unit, such as a microprocessor from the Intel® Pentium® family of microprocessors, the Intel® Itanium® family of microprocessors, and/or the Intel XScale® family of processors. The memories **1804**, **1806** and **1808** that are coupled to the processor **1802** may be any suitable memory devices and may be sized to fit the storage demands of the system **1800**. In particular, the flash memory **1808** may be a non-volatile memory that is accessed and erased on a block-by-block basis.

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The input device **1814** may be implemented using a keyboard, a mouse, a touch screen, a track pad, a barcode scanner or any other device that enables a user to provide information to the processor **1802**.

The display device **1816** may be, for example, a liquid crystal display (LCD) monitor, a cathode ray tube (CRT) monitor or any other suitable device that acts as an interface between the processor **1802** and a user. The display device **1816** as pictured in FIG. **18** includes any additional hardware required to interface a display screen to the processor **1802**.

The mass storage device **1818** may be, for example, a conventional hard drive or any other magnetic, optical, or solid state media that is readable by the processor **1802**.

The removable storage device drive **1820** may, for example, be an optical drive, such as a compact disk-recordable (CD-R) drive, a compact disk-rewritable (CD-RW) drive, a digital versatile disk (DVD) drive or any other optical drive. It may alternatively be, for example, a magnetic media drive and/or a solid state universal serial bus (USB) storage drive. The removable storage media **1824** is complimentary to the removable storage device drive **1820**, inasmuch as the media **1824** is selected to operate with the drive **1820**. For example, if the removable storage device drive **1820** is an optical drive, the removable storage media **1824** may be a CD-R disk, a CD-RW disk, a DVD disk or any other suitable optical disk. On the other hand, if the removable storage device drive **1820** is a magnetic media device, the removable storage media **1824** may be, for example, a diskette or any other suitable magnetic storage media.

The network adapter **1822** may be, for example, an Ethernet adapter, a wireless local area network (LAN) adapter, a telephony modem, or any other device that allows the processor system **1800** to communicate with other processor systems over a network. The external network **1826** may be a LAN, a wide area network (WAN), a wireless network, or any type of network capable of communicating with the processor system **1800**. Example networks may include the Internet, an intranet, and/or an ad hoc network.

It is noted that this patent claims priority from Indian Patent Application Serial Number 1486/Che/2010, which was filed on May 31, 2010, and is hereby incorporated by reference in its entirety.

While the above specification described example systems, methods and articles of manufacture, the examples are not the only way to implement such systems, methods and articles of manufacture. Therefore, although certain example methods, apparatus and articles of manufacture have been described herein, the scope of coverage of this patent is not limited thereto. On the contrary, this patent covers all methods, apparatus and articles of manufacture fairly falling within the scope of the appended claims either literally or under the doctrine of equivalents.

What is claimed is:

1. A method to determine a first network efficacy of a first social networking site to facilitate delivery of an advertisement to a user of the first social networking site, the method comprising:

accessing, by executing an instruction with a processor, interaction data and contact data for the user of the first social networking site via an interface provided by the first social networking site;

determining, by executing an instruction with the processor, a connectedness for the user based on the contact data;

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determining, by executing an instruction with the processor, an interactivity for the user based on the interaction data;

determining, by executing an instruction with the processor, a network constancy for the user by determining a ratio of (a) connections between contacts of the user of the first social networking site to (b) at least one of:

(1) broken connections between the contacts of the user in response to removal of the user from the first social networking site; or

(2) connections between the contacts of the user that exhibit changed degrees of connection in response to removal of the user from the first social networking site;

determining, by executing an instruction with the processor, the first network efficacy of the first social networking site based on the connectedness, the interactivity, and the network constancy, the network constancy being based on the ratio; and

transmitting the first network efficacy from the processor to an advertising server to facilitate delivery of the advertisement from the advertising server to the user of the first social networking site.

2. The method as defined in claim 1, wherein the determining of the network constancy includes determining a number of connections between users in the first social networking site that are based on the presence of the user in the first social networking site.

3. The method as defined in claim 1, wherein the determining of the connectedness is based on a number of first-degree contacts of the user and a number of second-degree contacts of the user, and the determining of the connectedness includes assigning a first weight to a first one of the first-degree contacts who has restricted a connection with the user, and assigning a second weight to a second one of the first-degree contacts who has not restricted a connection with the user.

4. The method as defined in claim 1, wherein the determining of the interactivity of the user includes:

determining a number of first interactions directed from the user to a first one of the contacts by generating at least one of a matrix or a vector representative of an interaction between the user and the first one of the contacts; and

determining a number of second interactions associated with the first interaction and the first one of the contacts by generating or updating the at least one of the matrix or the vector representative of an interaction between the user and the first one of the contacts.

5. The method as defined in claim 1, further including comparing the first network efficacy of the first social networking site to a second network efficacy of a second social networking site used by the user, and selecting the first social networking site for delivery of advertisements to the user based on the comparison.

6. An apparatus to determine a first network efficacy of a first social networking site to facilitate delivery of an advertisement to a user of the first social networking site, the apparatus comprising:

a user selector to access interaction data and contact data for the user of the first social networking site via an interface provided by the first social networking site; an interactivity monitor to determine an interactivity for the user based on the interaction data;

a connectedness monitor to determine a connectedness for the user based on the contact data and to determine a network constancy for the user by determining a ratio

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of (a) connections between contacts of the user of the first social networking site to (b) at least one of:

(1) broken connections between the contacts of the user in response to removal of the user from the first social networking site; or

(2) connections between the contacts of the user that exhibit changed degrees of connection in response to removal of the user from the first social networking site; and

a network efficacy determiner to determine the first network efficacy of the first social networking site based on the connectedness, the interactivity, and the network constancy, the network constancy being based on the ratio, the network efficacy determiner to transmit the first network efficacy to an advertising server to facilitate delivery of the advertisement from the advertising server to the user of the first social networking site.

7. The apparatus as defined in claim 6, wherein the connectedness monitor is to determine the network constancy by determining a number of connections between users in the first social networking site that are based on the presence of the user in the first social networking site.

8. The apparatus as defined in claim 6, wherein the connectedness monitor is to determine the connectedness based on a number of first-degree contacts of the user and based on a number of second-degree contacts of the user, and the connectedness monitor is to determine the connectedness by assigning a first weight to a first one of the first-degree contacts who has restricted a connection with the user and assigning a second weight to a second one of the first-degree contacts who has not restricted a connection with the user.

9. The apparatus as defined in claim 6, wherein the interactivity monitor is to determine the interactivity of the user by:

determining a number of first interactions directed from the user to a first one of the contacts by generating at least one of a matrix or a vector representative of an interaction between the user and the first one of the contacts; and

determining a number of second interactions associated with the first interaction and the first one of the contacts by generating or updating the at least one of the matrix or the vector representative of an interaction between the user and the first one of the contacts.

10. The apparatus as defined in claim 6, wherein the network efficacy determiner is to store the first network efficacy of the first social networking site for subsequent selection of the first social networking site or a second social networking site used by the user for delivery of advertisements to the user based on a comparison of the first network efficacy to a second network efficacy of the second social networking site.

11. A tangible computer readable storage medium, comprising computer readable instructions which, when executed, cause a processor to at least:

access interaction data and contact data for a user of a first social networking site via an interface provided by the first social networking site;

determine a connectedness for the user based on the contact data;

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determine an interactivity for the user based on the interaction data;

determine a network constancy for the user by determining a ratio of (a) connections between contacts of the user of the first social networking site to (b) at least one of:

(1) broken connections between the contacts of the user in response to removal of the user from the first social networking site; or

(2) connections between the contacts of the user that exhibit changed degrees of connection in response to removal of the user from the first social networking site;

determine a first network efficacy of the first social networking site based on the connectedness, the interactivity, and the network constancy, the network constancy being based on the ratio; and

transmit the first network efficacy to an advertising server to facilitate delivery of an advertisement to the user of the first social networking site.

12. The storage medium as defined in claim 11, wherein the instructions are to cause the processor to determine the network constancy by determining a number of connections between users in the social networking site that are based on the presence of the user in the first social networking site.

13. The storage medium as defined in claim 11, wherein the instructions are to cause the processor to determine the connectedness based on a number of first-degree contacts of the user and a number of second-degree contacts of the user, and the instructions are to cause the processor to determine the connectedness by assigning a first weight to a first one of the first-degree contacts who has restricted a connection with the user and assigning a second weight to a second one of the first-degree contacts who has not restricted a connection with the user.

14. The storage medium as defined in claim 11, wherein the instructions are to cause the processor to determine the interactivity of the user by:

determining a number of first interactions directed from the user to a first one of the contacts by generating at least one of a matrix or a vector representative of an interaction between the user and the first one of the contacts; and

determining a number of second interactions associated with the first interaction and the first one of the contacts by generating or updating the at least one of the matrix or the vector representative of an interaction between the user and the first one of the contacts.

15. The storage medium as defined in claim 11, wherein the instructions are further to cause the processor to compare the first network efficacy of the first social networking site to a second network efficacy of a second social networking site used by the user, and select the first social networking site for delivery of advertisements to the user based on the comparison.

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